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1998–2000
Graduate
Degree
Programs
Bulletin



1998–00 Graduate Degree Programs Bulletin

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Address General Inquiries Regarding the Graduate School to:
 Graduate School
 The Pennsylvania State University
 114 Kern Building
 University Park, PA 16802-3300
 (814) 865-2516
<http://www.gradsch.psu.edu>

Directory Assistance for University Telephone Numbers:
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304 Old Main
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(814) 863-9580

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The Pennsylvania State University
114 Kern Building
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DIRECTORY OF GRADUATE PROGRAMS AND DEGREES CONFERRED

The following degrees are the ones normally conferred in each of the designated major programs. Page references below are to the pages in the 1998-00 *Graduate Bulletin* where the individual program, including faculty, specific admission and degree requirements, and course offerings, is described. Unless otherwise noted, programs are located at University Park campus.

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GRADUATE CALENDAR*

SUMMER SESSION 1998

The Graduate School does not have a deadline for processing applications. (Exception: International applicants must submit materials at least four months before the beginning of the semester for which they are applying.) Applicants should ascertain application deadlines by contacting the individual graduate program. Applications should be submitted as early as possible.

MAY

- 11 Monday—Intersession begins
- 25 Monday—Memorial Day holiday
- 26 Tuesday—Last date for a summer graduate to schedule final oral doctoral examination

JUNE

- 5 Friday—Intersession classes end
- 9 Tuesday—8-week registration deadline
- 10 Wednesday
 - 8-week classes begin
 - Last date for a summer graduate to activate intent to graduate (Registrar's Office)
- 12 Friday
 - Last date for a summer graduate to submit a complete draft of the doctoral thesis to the Thesis Office for format review
- 15 Monday
 - Last date for summer graduate to submit a complete draft of the master's thesis to the Thesis Office for format review
 - Last date for department to certify to Graduate Enrollment Services that student has submitted a complete draft of the master's paper for summer graduation
- 23 Tuesday—6-week registration deadline
- 24 Wednesday—6-week classes begin
- 26 Friday—Applications for fall semester tuition grants-in-aid due in 313 Kern
- 29 Monday—Last day for summer graduate to pass final oral doctoral examination.
Department must return report form to Graduate Enrollment Services immediately.

JULY

- 3 Friday—Independence Day holiday
- 17 Friday
 - Last date for summer graduate to submit final, corrected, signed copy of thesis to Thesis Office
 - Last date for student to submit final, corrected master's paper to **department**. This does **not** have to be communicated to the Graduate School

AUGUST

- 5 Wednesday—All classes end
- 6–7 Thursday–Friday—Final examinations
- 8 Saturday—Summer commencement

*This calendar applies to University Park campus. It is subject to change without notice. Calendars for other graduate campuses of the University may differ. Inquiries should be directed to the appropriate campus. In preparing the calendar for an academic year, the University makes every effort to avoid conflict with religious holidays. However, such conflicts are sometimes unavoidable. When they occur, efforts are made to make special arrangements for the students affected.

FALL SEMESTER 1998

The Graduate School does not have a deadline for processing applications. (Exception: International applicants must submit materials at least four months before the beginning of the semester for which they are applying.) Applicants should ascertain application deadlines by contacting the individual graduate program. Applications should be submitted as early as possible.

AUGUST

- 11 Tuesday—Arrival day for international students
- 14–18 Friday–Tuesday—Orientation for international students
- 22 Saturday—Arrival day for new students
- 23 Sunday—Arrival day for returning students
- 25 Tuesday—Registration deadline
- 26 Wednesday—Classes begin

SEPTEMBER

- 7 Monday—Labor Day holiday
- 15 Tuesday—Last day for fall graduate to activate intent to graduate (Registrar's Office)
- 21 Monday—Last date for a fall graduate to schedule final oral doctoral examination

OCTOBER

- 9 Friday—Last date for fall graduate to submit a complete draft of the doctoral thesis to the Thesis Office for format review
- 12 Monday
 - Last date for department to certify to Graduate Enrollment Services that student has submitted a complete draft of the master's paper for fall graduation
 - Last date for a fall graduate to submit a complete draft of the master's thesis to the Thesis Office
- 19 Monday—Last date for a fall graduate to pass final oral doctoral examination. Department must return report form to Graduate Enrollment Services immediately.
- 26 Monday—Applications for spring semester tuition grants-in-aid due in 313 Kern

NOVEMBER

- 26–29 Thursday–Sunday—Thanksgiving holiday
- 30 Monday
 - Last date for fall graduate to submit final, corrected, signed copy of thesis to the Thesis Office
 - Last date for student to submit final, corrected master's paper to **department**. This does **not** have to be communicated to the Graduate School.

DECEMBER

- 1 Tuesday—Nominations for the Graduate Assistant Outstanding Teaching Award and the Graduate Faculty Teaching Award due in 313 Kern
- 11 Friday—Classes end
- 14–19 Monday–Saturday—Final examinations
- 20 Sunday—Fall commencement

SPRING SEMESTER 1999

The Graduate School does not have a deadline for processing applications. (Exception: International applicants must submit materials at least four months before the beginning of the semester for which they are applying.) Applicants should ascertain application deadlines by contacting the individual graduate program. Applications should be submitted as early as possible.

JANUARY 1999

- 4 Monday—Arrival day for international students
- 6 Wednesday—Arrival day
- 6, 7 Wednesday, Thursday—Orientation for international students
- 7, 8 Thursday, Friday—Orientation and registration
- 8 Friday—Registration deadline
- 11 Monday—Classes begin
- 25 Monday—Last date for spring graduate to activate intent to graduate (Registrar's Office)

FEBRUARY

- 15 Monday—Completed application materials for incoming graduate students for 1999–2000 fellowships awarded by the Graduate School due in 313 Kern
- 22 Monday—Last date for a spring graduate to schedule final oral doctoral examination

MARCH

- 3 Wednesday—Last date for spring graduate to submit a complete draft of the doctoral thesis to the Thesis Office for format review
- 5 Friday—Last date for spring graduate to submit a complete draft of the master's thesis to Thesis Office for format review
- 10 Monday—Last date for department to certify to Graduate Enrollment Services that student has submitted a complete draft of the master's paper for spring graduation
- 8–12 Monday–Friday—Spring holiday
- 19 Friday—Applications for summer session tuition grants-in-aid due in 313 Kern
- 22 Monday—Last date for spring graduate to pass final oral doctoral examination. Department must return report form to Graduate Enrollment Services immediately.

APRIL

- 1 Thursday—Graduate School tuition assistance applications for summer session are due in 313 Kern
- 19 Monday
 - Last date for spring graduates to submit final, corrected, signed copy of thesis to the Thesis Office
 - Last date for student to submit final, corrected master's paper to **department**. This does **not** have to be communicated to the Graduate School.
- 30 Friday—Classes end

MAY

- 3–8 Monday–Saturday—Final examinations
- 16 Sunday—Spring commencement

SUMMER SESSION 1999

The Graduate School does not have a deadline for processing applications. (Exception: International applicants must submit materials at least four months before the beginning of the semester for which they are applying.) Applicants should ascertain application deadlines by contacting the individual graduate program. Applications should be submitted as early as possible.

MAY

- 10 Monday—Interession begins
- 25 Tuesday—Last date for a summer graduate to schedule final oral doctoral examination
- 31 Monday—Memorial Day holiday

JUNE

- 4 Friday—Interession classes end
- 8 Tuesday—8-week registration deadline
- 9 Wednesday
 - 8-week classes begin
 - Last date for a summer graduate to activate intent to graduate (Registrar's Office)
- 11 Friday—Last date for a summer graduate to submit a complete draft of doctoral thesis to Thesis Office for format review
- 14 Monday
 - Last day for a summer graduate to submit complete draft of the master's thesis to Thesis Office for format review
 - Last date for department to certify to Graduate Enrollment Services that student has submitted a complete draft of the master's paper for summer graduation
- 22 Tuesday—6-week registration deadline
- 23 Wednesday—6-week classes begin
- 25 Friday—Applications for fall semester tuition grants-in-aid due in 313 Kern
- 2 Monday—Last date for a summer graduate to pass final oral doctoral examination.
Department must return report form to Graduate Enrollment Services immediately.

JULY

- 5 Monday—Independence Day holiday
- 16 Friday
 - Last date for summer graduate to submit final, corrected, signed copy of thesis to Thesis Office
 - Last date for student to submit final, corrected master's paper to **department**. This does **not** have to be communicated to the Graduate School.

AUGUST

- 4 Wednesday—All classes end
- 5–6 Thursday–Friday—Final examinations
- 7 Saturday—Summer commencement

FALL SEMESTER 1999

The Graduate School does not have a deadline for processing applications. (Exception: International applicants must submit materials at least four months before the beginning of the semester for which they are applying.) Applicants should ascertain application deadlines by contacting the individual graduate program. Applications should be submitted as early as possible.

AUGUST

- 10 Tuesday—Arrival day for international students
- 13–17 Friday–Tuesday—Orientation for international students
- 21 Saturday—Arrival day for new students
- 22 Sunday—Arrival day for returning students
- 24 Tuesday—Registration deadline
- 25 Wednesday—Classes begin

SEPTEMBER

- 6 Monday—Labor Day holiday
- 14 Tuesday—Last day for fall graduate to activate intent to graduate (Registrar's Office)
- 20 Monday—Last date for fall graduate to schedule final oral examination

OCTOBER

- 8 Friday—Last date for fall graduate to submit a complete draft of the doctoral thesis to Thesis Office for format review
- 11 Monday
 - Last date for fall graduate to submit complete draft of the master's thesis to Thesis Office for format review
 - Last date for department to certify to Graduate Enrollment Services that student has submitted a complete draft of the master's paper for fall graduation
- 18 Monday—Last date for fall graduate to pass final oral doctoral examination. Department must return report form to Graduate Enrollment Services immediately.
- 25 Monday—Applications for spring semester tuition grants-in-aid are due in 313 Kern Building

NOVEMBER

- 25–28 Thursday–Sunday—Thanksgiving holiday (classes end at 12:05 p.m. on November 24)
- 29 Monday
 - Last date for fall graduate to submit final, corrected, signed copy of thesis to Thesis Office
 - Last date for student to submit final, corrected master's paper to **department**. This does **not** have to be communicated to the Graduate School

DECEMBER

- 1 Wednesday—Nominations for the Graduate Assistant Outstanding Teaching Award and the Graduate Faculty Teaching Award are due in 313 Kern.
- 12 Friday—Classes end
- 13–18 Monday–Saturday—Final examinations
- 19 Sunday—Fall commencement

SPRING SEMESTER 2000

The Graduate School does not have a deadline for processing applications. (Exception: International applicants must submit materials at least four months before the beginning of the semester for which they are applying.) Applicants should ascertain application deadlines by contacting the individual graduate program. Applications should be submitted as early as possible.

JANUARY 2000

- 3 Tuesday—Arrival day for international students
- 5, 6 Wednesday, Thursday—Orientation for international students
- 5 Wednesday—Arrival day
- 7 Friday—Registration deadline
- 10 Monday—Classes begin
- 24 Monday—Last date for spring graduate to activate intent to graduate (Registrar's Office)

FEBRUARY

- 15 Tuesday—Completed application materials for incoming graduate students for 2000—2001 fellowships awarded by the Graduate School due in 313 Kern
- 21 Monday—Last date for spring graduate to schedule final oral examination

MARCH

- 1 Wednesday—Last date for spring graduate to submit a complete draft of the doctoral thesis to Thesis Office for format review
- 3 Friday
 - Last date for a spring graduate to submit complete draft of the master's thesis to Thesis Office for format review
 - Last date for department to certify to Graduate Enrollment Services that student has submitted a complete draft of the master's paper for fall graduation
- 6–10 Monday–Friday—Spring holiday
- 20 Monday—Last date for a spring graduate to pass final oral doctoral examination. Department must return report form to Graduate Enrollment Services immediately.
- 31 Friday
 - Applications for summer session tuition grants-in-aid due in 313 Kern
 - Graduate School tuition assistance applications for summer session due in 313 Kern

APRIL

- 17 Monday
 - Last date for spring graduate to submit final, corrected, signed copy of thesis to the Thesis Office
 - Last date for student to submit final, corrected master's paper to **department**. This does **not** have to be communicated to the Graduate School.
- 28 Friday—Classes end

MAY

- 1–6 Monday–Saturday—Final examinations
- 14 Sunday—Spring commencement

SUMMER SESSION 2000

The Graduate School does not have a deadline for processing applications. (Exception: International applicants must submit materials at least four months before the beginning of the semester for which they are applying.) Applicants should ascertain application deadlines by contacting the individual graduate program. Applications should be submitted as early as possible.

MAY

- 8 Monday—Intersession begins
- 23 Tuesday—Last date for a summer graduate to schedule final oral doctoral examination
- 29 Monday—Memorial Day holiday

JUNE

- 2 Friday—Intersession classes end
- 6 Tuesday—8-week registration deadline
- 9 Friday—Last date for a summer graduate to submit a complete draft of the doctoral thesis to Thesis Office for format review
- 12 Monday
 - Last date for summer graduate to submit a complete draft of the master's thesis to Thesis Office for format review
 - Last date for department to certify to Graduate Enrollment Services that student has submitted a complete draft of the master's paper for summer graduation
- 14 Wednesday
 - 8-week classes begin
 - Last date for a summer graduate to activate intent to graduate in the Registrar's Office
- 20 Tuesday—6-week registration deadline
- 23 Friday—Applications for fall semester tuition grants-in-aid due in 313 Kern
- 26 Monday—Last day for summer graduate to pass final oral doctoral examination. Department must return report form to Graduate Enrollment Services immediately.
- 28 Wednesday—6-week classes begin

JULY

- 4 Tuesday—Independence Day holiday
- 14 Friday
 - Last date for summer graduate to submit final, corrected, signed copy of thesis to Thesis Office
 - Last date for student to submit final, corrected master's paper to **department**. This does **not** have to be communicated to the Graduate School

AUGUST

- 9 Wednesday—All classes end
- 10–11 Thursday–Friday—Final examinations
- 12 Saturday—Summer commencement

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THE GRADUATE SCHOOL

HISTORY

Graduate work was first offered at Penn State in 1862. Some years later, a committee of the General Faculty was given the responsibility of establishing standards and regulations governing graduate work and the granting of master's and certain technical degrees. The Graduate School was formally established in 1922 by the President and the Board of Trustees. An administrative staff was organized, and the Graduate Faculty was formed. The University Senate delegated to this faculty responsibility for graduate affairs, subject to review.

In 1924, the Board of Trustees authorized the granting of the degree of Doctor of Philosophy, and the first Ph.D. was awarded in 1926. On May 9, 1971, a Graduate Council was established for the Graduate School. Today, graduate study is offered in about 137 major programs, with 19 advanced academic and professional degrees being conferred. During the academic year 1997–1998 approximately 9,994 graduate students were enrolled and approximately 2,509 advanced degrees were conferred in 1996–97, of which 543 were doctorates.

The Graduate School is a member of the Association of Graduate Schools (an organization within the Association of American Universities) and of the Council of Graduate Schools in the United States.

THE GRADUATE FACULTY

The major role of the Graduate School is to emphasize the aspects of University activity that pertain directly to major programs in graduate study. Through its Graduate Faculty it represents a large segment of the academic strength of the University and thus is a dominant force in sustaining and furthering the intellectual quality of the entire institution. The departments and colleges of the University formulate study and research programs appropriate to their fields. The Graduate Faculty consists of members of the college faculties who have authorization through the Graduate School to offer courses and seminars and supervise research and theses consistent with the highest academic standards. Thus, the Graduate School may be regarded as a federation of selected segments of the college faculties.

THE GRADUATE COUNCIL

The governance of the Graduate School is vested in the Graduate Council, whose legislative authority is subject to the specific restrictions of the "Articles of Authority, Standing Rules, and Bylaws of the University Graduate Council."

The Committee on Committees and Procedures recommends appointment of members of all other committees of the council and periodically reviews the committee structure and recommends changes as necessary.

The Executive Committee assists the council chair in setting the agenda for council meetings and provides advice and counsel, as requested, to the dean of the Graduate School.

The Committee on Academic Standards recommends to the council criteria for membership in the Graduate Faculty, standards and policies for the admission of students, and thesis regulations and requirements. The committee also advises the dean and the council on a variety of issues that relate to standards in graduate education at Penn State.

The Committee on Programs and Courses is responsible to the council for evaluation, review, and recommendations regarding new and existing graduate courses and programs.

The Committee on Graduate Research informs and advises the council on issues, procedures, and opportunities relating to graduate research and fosters outstanding graduate research through special recognitions and awards.

The Committee on Graduate Student and Faculty Affairs studies and recommends actions to further the cultural, intellectual, social, and ethical environment of the graduate community, and assists the dean in the review of sanctions or appeals as needed.

The Committee on Fellowships and Awards considers policies and evaluates applications for Graduate School fellowships and other awards.

ADMINISTRATION

Executive and administrative matters of the Graduate School are the responsibility of the dean, who is charged directly with enforcement of the regulations of the Graduate School and with organization of its administrative procedures. The dean has a major responsibility to enhance and ensure the high quality of graduate study and research of graduate students. The dean exercises leadership in initiating new programs

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and in restructuring or phasing out marginal and obsolete ones and encourages and assists in the development of interdisciplinary programs. The dean is assisted in this work by an administrative and clerical staff.

The main administrative offices of the Graduate School are located at the University Park campus. Appropriate graduate offices and services also are at the other four graduate campuses of the University. Each of them publishes informational materials pertaining to its own graduate programs, physical facilities, library, faculty, and scholarly resources. Those materials supplement the information provided in this *Bulletin*.

The University Park offices of the Graduate School are located in the Kern Building. A student may go to any of the Graduate School's four major administrative divisions for answers to questions that require administrative assistance or decisions:

1. Graduate Enrollment Services, 114–115 Kern. The Office of Graduate Enrollment Services has responsibility for processing all matters pertaining to a student's admission. The functions of the office encompass responsibilities for the academic involvement and concerns of all graduate students from the time they are admitted until they graduate, such as (a) registration of students, (b) readmission of students, (c) maintenance of records, (d) appointment of graduate committees for doctoral students, (e) scheduling of graduate student comprehensive and final oral examinations, (f) checking for accomplishment by students of Graduate Faculty requirements for all advanced degrees and preparation of official commencement lists, and (g) attention to student academic problems.

2. Graduate Minority Affairs, 308 Kern. The Center for Minority Graduate Opportunities and Faculty Development provides extensive information, advice, and assistance to prospective and enrolled minority graduate students and coordinates minority graduate recruitment and retention activities in the colleges of the University.

3. Graduate Fellowships and Awards, 313 Kern. The Office of Graduate Fellowships and Awards serves as a clearinghouse for information on available fellowships and other awards for graduate students, administers fellowships and other award programs involving students in more than one college, and seeks support for graduate students attending the University.

4. Theses, 115 Kern. The Thesis Office is responsible for reviewing all theses to ensure that they meet format requirements consistent with the attainment of high scholarly standards and for providing information on thesis preparation.

PROGRAM LOCATIONS

Programs of graduate study are offered at five locations in Pennsylvania:

Penn State Erie—Penn State Erie, The Behrend College (Station Road, Erie, PA 16563-0107) provides convenient opportunities for graduate education to persons residing in northwestern Pennsylvania. It offers a program leading to the degree of Master of Business Administration.

Penn State Harrisburg—Penn State Harrisburg (777 W. Harrisburg Pike, Middletown, PA 17057), close to the state capital at Harrisburg, was opened in 1966. Graduate programs leading to the degrees of Master of Arts with majors in American Studies, Humanities, and Applied Psychology; Master of Business Administration; Master of Community Psychology; Master of Education with majors in Health Education, Teaching and Curriculum, and Training and Development; Master of Engineering with a major in Engineering Science; Master of Environmental Pollution Control and Master of Science in Environmental Pollution Control; Master of Science in Information Systems; Master of Public Administration; Master of Health Administration; and Doctor of Philosophy degree in Public Administration are currently offered. Cooperative programs between Penn State Harrisburg and University Park lead to the Master of Education and the Doctor of Education degrees in Adult Education.

College of Medicine—The University's College of Medicine at The Milton S. Hershey Medical Center (500 University Drive, Box 850, Hershey, PA 17033) was established in 1963, and the first class of medical students entered in the fall of 1967. In conjunction with Penn State's Graduate School, the College of Medicine offers programs leading to the Master of Science degree with a major in Laboratory Animal Medicine, and to the Doctor of Philosophy and Master of Science degrees with majors in Anatomy, Biochemistry and Molecular Biology, Cell and Molecular Biology, Microbiology and Immunology, Neuroscience, Pharmacology, and the intercollege programs in Bioengineering, Genetics, Integrative Biosciences, and Physiology.

Penn State Great Valley—Penn State Great Valley School of Graduate Professional Studies (30 E. Swedesford Road, Malvern, PA 19355) is situated at the gateway to the Great Valley Corporate Center near

Philadelphia. Founded in 1963, this graduate center offers programs leading to the degrees of Master of Business Administration, Master of Education with majors in Curriculum and Instruction, Special Education, and Instructional Systems; Master of Environmental Pollution Control; Master of Engineering with majors in Electrical Engineering, Engineering Science, Environmental Engineering, Industrial Engineering, and Systems Engineering; and Master of Science with majors in Curriculum and Instruction, Information Science, Instructional Systems, and Special Education.

University Park Campus—University Park (PA 16802), located in the municipality of State College in central Pennsylvania, is the largest of the Penn State campuses and offers more than one hundred graduate programs.

Graduate degree programs based at any of the five administrative centers of the Graduate School listed above, but offered at locations away from those centers, may be discontinued at any time. Degree candidates will be eligible to continue the program, but this may require attendance at courses offered only at the center where the program is based. The University will provide notice of the discontinuance of any program offered at an off-center site at least one semester in advance and furnish information concerning available options for continuance in the program.

RESEARCH FACILITIES

Of the University's more than 16,000 acres of land, a substantial portion consists of recreation areas, farms and agricultural experiment grounds, and forest tracts that are used by graduate students in their work and research. Animal and wildlife students, for example, are conducting nutrition and physiology studies of whitetail deer and blue duikers (tiny African antelope), sheltered at one of the forest tracts. Astronomy students use an observatory housing the largest telescope east of the Rockies. Those in civil engineering can carry out research at the only highway test track in Pennsylvania. Laboratories and equipment devoted to meteorology, mining, chemistry, combustion, biomechanics, engineering acoustics, psychology, and microbiology mirror the University's strengths in those disciplines. Biotechnology and microelectronics groups are well established here, and centers of expertise in computer-assisted design and manufacture, as well as robotics, have emerged. The Life Sciences Consortium provides centralized facilities for all researchers in the biological sciences, and the Materials Research Institute offers new opportunities for multidisciplinary education and research within the materials-related disciplines.

In addition to research conducted in academic departments or in organized research units within the individual colleges, opportunities for interdisciplinary research exist in several intercollege research units: Applied Research Laboratory, Environmental Resources Research Institute, Institute for the Arts and Humanistic Studies, Materials Research Laboratory, Pennsylvania Transportation Institute, Population Research Institute, and Institute for Policy Research and Evaluation. The Animal Resource Program also provides University-wide services for instruction as well as research opportunities for graduate students.

THE UNIVERSITY LIBRARIES

The University Libraries constitute a major resource for students and researchers in all fields of study. The Libraries, ranked eighteenth nationally by the Association of Research Libraries, contain over 4.0 million volumes, 3.3 million microforms, and 31,000 current serial titles.

The Libraries include a central collection and seven branch libraries at University Park campus, and libraries at Penn State Erie, Penn State Harrisburg, Dickinson School of Law, Penn State Great Valley, and at each of Penn State's other campuses.

At University Park campus, the Humanities and Social Sciences Libraries, the Gateway Library (encompassing many reference services), the Arts Library, and the Life Sciences Library are maintained in Pattee Library. The branch libraries include the Architecture Library, Earth and Mineral Sciences Library, Education Library, Engineering Library, Mathematics Library, Pollock Library, and the Physical Sciences Library. Pollock Library's collection covers all subjects, focusing on topics of current interest.

Penn State is a recognized leader in library automation with the internally developed computerized Library Information Access System (LIAS), a core information service for Penn State faculty, students, and staff. More than just a catalog to the University Libraries materials, LIAS has evolved into a dynamic, integrated information system that provides electronic access to a great variety of materials (including some full text) in many subject areas.

LIAS now offers access to ABI/INFORM (business and finance), AGRICOLA (agriculture), Anthropological Literature (anthropology), ARTFL (French literature), Avery Index (architecture), BIP (books in print), CINAHL (nursing and allied health), EIP (engineering), ERIC (education), GPO Access (legislative

bills, debates, regulations), Index to Government Publications (government), Mass Media Index (mass media journals), Medianet (AVS films and videotapes), MEDLINE (medicine and allied health), Newspaper Abstracts (general information), NTIS (government research), PAIS (contemporary issues), PENpages (agriculture and nutrition), Periodical Abstracts (general information), PsycInfo (psychology), RLIN (Research Libraries database), Table of Contents (multidisciplinary). The Libraries also provide Internet access to electronic information in many diverse areas at www.libraries.psu.edu on the Web.

Remote access to LIAS from terminals on or off campus is also available via direct-dial service. Introductory sessions are offered on a regular basis to familiarize faculty, students, and other library users with LIAS. Guides to using LIAS are available at all public service locations and at www.libraries.psu.edu/pubinfo/remotearchive.html on the Web.

Services offered to library users include computerized literature searches in a variety of databases and a resource sharing network through the Libraries Interlibrary Loan to facilitate obtaining information not in the collections.

The University Libraries' Audio-Visual Services, one of the nation's largest university media libraries, makes available more than 16,500 films and video titles for use in classroom instruction. Established in 1941, the library is composed of a main collection and several specialized collections. To facilitate individual research, an on-line database, Medianet, is available through LIAS providing public access to media titles and keyword subject headings. Reference and consultation services are also available. Assistance in locating specific titles is provided during working hours, and preview facilities are located in Willard Building. Films and videos may be checked out on a short-term basis for research and credit instruction. For more information, call 863-3202.

Additional library services include assigned study carrels, photocopiers, a student lounge with vending machines, change machines, and assistance for users with disabilities.

Your Guide to the University Libraries and *University Libraries: An Orientation to Library Services for Faculty* offer additional information on each of these services and programs and are available through the Libraries Public Information Office, C308 Pattee.

THE PENN STATE PRESS

The Penn State Press is a publisher of scholarly books and several journals for the advancement of scholarship. It publishes in most areas of the humanities and social sciences, giving emphasis to art and architectural history, literature and literary criticism, philosophy, religious studies, history, political science, women's studies, sociology, Latin American studies, East European and Russian Studies, and studies of science, technology, and society. Its journals include *The Chaucer Review*, *Legacy*, *Resources for American Literary Study*, *Philosophy and Rhetoric*, *The Journal of General Education*, *Journal of Speculative Philosophy*, *Comparative Literature Studies*, *The Journal of Policy History*, *Book History*, and *Shaw: The Annual of Bernard Shaw Studies*. The Press publishes fifteen series: African American Authors (Editor: Bernard Bell); Hermeneutics: Studies in the History of Religions (Editor: Kees Bolle); Issues in Policy History (Editor: Donald T. Critchlow); Kenneth Scott Latourette Prize in Religion and Modern History (sponsored by the Conference on Faith and History); Literature and Philosophy (Editor: Anthony J. Cascardi); Penn State Series in the History of the Book (Editor: James L. W. West III); Penn State Series in Lived Religious Experience (Editor: Judith Van Herik); Penn State Studies in Romance Literatures (Editors: Frederick A. DeArmas, Alan E. Knight, and Allan Stoekl); Post-Communist Cultural Studies (Editor: Thomas Cushman); Renaissance Art Texts (Editor: Creighton Gilbert); Re-reading the Canon (Editor: Nancy Tuana); Studies of the Greater Philadelphia Philosophy Consortium (Editors: Michael Krausz and Joseph Margolis); Rural Studies Series (Editor: Bo Beaulieu); Penn State History of Jewish Literature (Editors: Baruch Halpern and Aminadar Dykman); American and European Philosophy Series (Editors: Charles Scott and John Stuhr).

THE CENTER FOR ACADEMIC COMPUTING (CAC)

As the principal service unit responsible for academic computing, the Center for Academic Computing (CAC) provides Penn State's academic community with high-quality computing and related information technology services. These services, listed at <http://cac.psu.edu> on the Web, are provided through a professional staff and technical resources and are fundamental to fulfilling the University's Strategic Plan for Academic Computing, directly supporting the teaching, research, and service goals of the University.

The CAC has a leadership role in evaluating emerging technologies and provides a broad range of services and production facilities supporting the many facets of Penn State's academic programs. Services include intra-university consulting, electronic mail, Internet access, computer laboratories, technology classrooms, desktop and mainframe computing, workshops and technical seminars on academic informa-

tion technology, specialized facilities supporting advanced information technologies, graduate education and research support, and courseware development.

—**Computer Consulting Services** are offered at Help Desks and Computer Labs. Locations of Help Desks and announcements pertaining to scheduled hours are posted on the consulting home page (<http://cac.psu.edu/consulting/index.html>).

—**Computer Laboratories** are provided by the CAC in over thirty locations across campus, some with twenty-four hour access. Resources in these labs include Apple Macintosh computers, IBM PCs and compatibles, high-function workstations, laser-quality printers, plotters, and many software packages (<http://cac.psu.edu/labs>).

—**Computer Training for Students, Faculty, and Staff** is provided by seminars, workshops and open houses throughout the year to help students, faculty, and staff get started with how to do computing in the Penn State computing environment. In addition, many seminars are presented on the use of common software applications. Training/seminar schedules are found at <http://cac.psu.edu/training/> on the CAC Web site.

—**E-mail and Internet Access** is provided to all students, faculty, and staff through a CAC provided Access Account (<http://cac.psu.edu/internet/accessaccount.html>) which enables the use of electronic mail, Internet services, CAC labs, and personal Web pages. Off-campus dial-in is available to all access account holders (<http://cac.psu.edu/internet/dialup>). All students, faculty, and staff are provided a personal space for a Web page upon request to <http://www.psu.edu/webpace/>

—**Students, faculty, and staff can purchase at educational discount** computer systems, peripherals, and software at the Microcomputer Order Center (<http://moc.cac.psu.edu>). An evaluation/demo laboratory along with consulting assistance is located in 12 Willard Building.

—**Large-scale computing services** (<http://cac.psu.edu/gears>) are provided through an IBM ES/9000-740 mainframe and an IBM SP scaleable parallel computer, a large networked computer cluster system that includes both local and remote connections as well as peripheral equipment such as plotters and printers.

—**Technology classrooms** (<http://classrooms.cac.psu.edu/Tech/about.htm>) provide a range of services for the classroom. These include projection equipment, data connections, desktop and laptop computers, and many other technology devices. The CAC has a leadership role in the development and maintenance of these classrooms with a focus on needs for the instructor and collaborative computing student needs.

—**Technology change is an important focus for the center** (<http://cac.psu.edu/ait>). The CAC looks at and experiments with innovative technologies through its own efforts and through cooperative projects with academic and research units of the University. Results are shared with the University community and, where appropriate, used to enhance the support services provided by the CAC.

—**Instructional support by the CAC** (<http://cac.psu.edu/ets>) includes consulting with faculty on the matching of technologies to specific instructional needs, consulting in the use and integration of existing instructional software, providing training in the tools for design and development of new instructional software, and developing new instructional software and tools in cooperation with faculty.

—**The Graduate Education and Research Services (GEaRS) group** (<http://cac.psu.edu/gears>) of the CAC serves the computing technology needs of graduate education and research at Penn State with services focusing on numerical intensive computing, visualization computing services, and other technologies relevant to graduate education and research.

SPECIALIZED COMPUTING FACILITIES

Penn State also provides distributed computing and information systems. Many academic computing facilities exist to support the specialized research and instructional requirements of the colleges and the intercollege research programs. Some of these facilities are described below.

Colleges—Penn State is extremely fortunate to be one of only twenty-two nationwide New Media Centers, all of which are supported by the New Media Center Consortium. The *College of Arts and Architecture* New Media Center operates an expanding college-based network of high-end Macintosh computers and workstations that allow the college's students to fully explore many emerging technologies such as computer graphics, digital imaging, video, animation, computer visualization, virtual reality and printing technologies. The center is part of a University-wide network of eighty workstations.

The School of Architecture and Landscape Architecture operates four student Macintosh-based computer labs and has integrated desktop computers into the studio environment. The high-speed Ethernet network incorporates a SGI Indigo and an Apple Workgroup fileserver to interconnect the two individual departments with one another, with the University-wide network, and with the Internet. The School of Architecture and Landscape Architecture computer labs, including the Stuckeman CAD Lab, are primarily

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used for teaching and research in such areas as computer graphics, computer-assisted drawing, design, and digital imaging, as well as exploration into computer visualization, virtual reality, and the World Wide Web. A wide variety of available input and output equipment, such as large-format printers, color printers, scanners, and video imaging and capturing equipment, allows faculty and students the opportunities to explore and master a variety of technologies and presentation techniques.

The School of Visual Arts' Computer Graphics Lab is a Macintosh-based facility used by students and faculty in all disciplines of the school. A variety of graphic applications as well as input and output options are supported. The school has additional loaned facilities that allow faculty and students to further explore multimedia production, Web page design and production, digital photography, and digital video, all emerging technologies that are being further integrated into the curriculum of the School of Visual Arts and the Department of Integrative Arts.

The School of Music provides students and faculty in all disciplines of the school with a Macintosh-based computer lab. Exploring newly emerging technologies in areas such as digital audio, multimedia, and musical composition are expanding the horizons of the once traditional exploration of the rigorous discipline of becoming a professionally trained musician.

The *College of Earth and Mineral Sciences* has a Cray supercomputer and numerous servers, workstations, and microcomputers in modern computer facilities to support teaching and research. The College has also installed a high-speed communications network that provides computer-to-computer communications within the college, as well as with external networks and computers via University facilities.

The Earth System Science Center (ESSC) Computing Facility has a Cray supercomputer, Sun SPARC servers, and numerous Sun and Silicon Graphics workstations. A very complete selection of software, including visualization packages, scientific libraries, and general circulation models, is offered. A tape archive facility is provided on the Cray.

The Meteorology Department supports an instructional and research applications facility with a suite of Digital Equipment Corporation (DEC) servers and workstations. The system, accessible by more than thirty X-terminals and terminals within the department, is interconnected by a local area network and is connected to worldwide networks, including networks operated by the National Aeronautics and Space Administration, as well as several centers with supercomputers, including the ESSC Cray and the National Center for Atmospheric Research. Other computers within the department are used for acoustic and turbulence data processing, acid deposition and micrometeorological monitoring, and control and signal processing of Doppler radars used in wind profilers and for cloud studies.

The mining engineering and petroleum and natural gas engineering sections support instructional and research applications with Sun SPARC servers and Sun and IBM workstations. Unique application software includes packages for simulating oil reservoirs and for designing strip and subsurface mines.

The Advanced Geographic Information Systems Laboratory in the geography department includes eight Sun SPARCstations and a Sun SPARCserver in a fully networked configuration. Color graphic hardcopy is available in the laboratory. Application software supported in this laboratory includes geographic information systems, image processing systems, and other software needed to directly support advanced spatial data analysis and graphics. Such packages currently include ARC/INFO, GRASS, and NCAR Graphics. Systems software includes a UNIX-based operating system, C, and FORTRAN.

The Department of Geography also hosts the Deasy GeoGraphics Laboratory, a cartographic design studio staffed by professional and student employees who produce print graphics, and instructional multimedia and visualization software using Macintosh, DOS/Windows, and UNIX platforms.

In the *College of Education*, Instructional and Technological Support Services (ITSS), located in 201 Chambers, provides support, consultation, and training in the use of various information technologies for College of Education faculty and staff. Staff within ITSS are also responsible for the setup, administration, and maintenance of the college's computer network. Application training for small groups is provided by ITSS staff in the college's Faculty/Staff Technology Development Center. ITSS also maintains a repository of educational software for review and evaluation by students and faculty within the college.

The IBM Personal Computer Lab, located in 202 Chambers, and the Macintosh Computer Lab, located in 205 Chambers, provide microcomputer access to the University community. Thirty networked IBM and twenty-eight Macintosh computers are available for student and faculty use. (The labs are restricted during certain hours; check schedule outside each room.)

Within the *College of Engineering*, each department has a variety of general and special-purpose computational resources for educational and research use. Additionally, the College of Engineering's Center for Electronic Design, Communication, and Computing provides expertise and support in the design, prototyping, testing, packaging, and complete integration of electronic systems; hardware and software resources for engineering design; and distributed access to these resources through the network

by the college research and educational community. Center resources include DEC Alpha computers, X-window terminals, and a number of high-performance workstations and design tools (View Logic, H-Spice, P-CAD, Cadence, AutoCAD, etc.). Also available are tools for embedded system development. Prototyping facilities consist of Xilinx and Altera systems for FPGA design implementation and a Direct Imaging system that allows rapid construction of multilayer printed circuit boards.

The Noll Physiological Research Center in the *College of Health and Human Development* has an Ethernet system, access to the Penn State backbone, UNIX, Image telemetry system, electronic mail services, and many types of PCs to collect and process data from a wide variety of physiological testing.

The Department of Communication Disorders uses several microcomputers for educational, research, and clinical needs related to speech, language, and hearing development and disorders. Specialized computer technology including CAFET, Speech Master II, VisiPitch, computerized speech laboratory, and computerized hearing assessment programs are available for use by students and faculty.

Within the *Eberly College of Science*, each department has an array of computer facilities.

The Department of Astronomy and Astrophysics maintains a network of more than eighty workstation-class machines, including seventy-four Suns, two SGIs, two IBMs, and one DEC Alpha. Additional functionality is given by a supporting array of X-terminals, Macs and PCs, a wide assortment of tape devices, and on-line disk storage exceeding 1/3 TByte. All machines are connected to the Internet and are also remotely accessible via dial-up lines provided by the University's Center for Academic Computing.

The Department of Biology maintains a computer laboratory in Mueller Lab, which provides facilities for both undergraduate and graduate instruction. All faculty and graduate student offices have Ethernet connections to the University network.

The Department of Chemistry has an eight-node IBM SP2 parallel machine for computationally intensive research, which is part of a forty-nine-node University-wide system. Numerous workstations and smaller computers are available in individual research groups. These computers are linked via Ethernet, which is connected to the University network, allowing access to research facilities worldwide.

The Department of Computer Science and Engineering maintains computer system laboratories in Pond Laboratory. The department currently supports 1,600 user accounts on 240 UNIX workstations and servers. A number of computer vendors are represented in the department's collection of systems, including Sun Microsystems, MIPS Computers, IBM, and others. These computer systems are connected to one or more of the nineteen currently installed Ethernets. A computer system in any office or other room in Pond Laboratory can easily be connected to any of the Ethernets. A connection to the campus ATM backbone allows any user to easily communicate with other research facilities around the world. The University has connections to the VBNS and commercial ISPs for access to other sites. Programming languages available to the users in the department include C, C++, Pascal, FORTRAN, Scheme, Prolog, ML, and Common LISP. For typesetting and document preparation, TeX, troff, and Framemaker are available. There is a large collection of VLSI/CAD tools, including the Berkeley OCTTOOLS and layout software from Cadence and Synopsys. The MathWork's MATLAB package and a number of its toolboxes are also available.

MATHNet, the local area network of the Department of Mathematics, comprises more than 100 UNIX workstations supporting approximately 500 users. Separate subnets are geared toward research, education, and departmental administration. Every graduate student office and nearly every faculty office in McAllister Building and Whitmore Laboratory is equipped with a workstation. MATHNet supports a large number of software packages relevant to mathematics research and education. Some of the programming languages available are FORTRAN, C, C++, and Pascal. For mathematical typesetting, there is an extensive TeX installation. Among the major scientific software libraries represented are the Modulef finite element library, the PLTMG adaptive multigrid finite element code, the CMLIB collection of mathematical software, and the LAPACK linear algebra library. Licensed software includes Mathematica, MatLab, Maple, and Macsyma.

The Department of Physics maintains three subnets that provide connectivity to computing resources for its students, faculty, and staff user base. Comprising some thirty-five Sun, eight SGI, nine DEC, three NeXT, and more than two hundred PC, Mac, and Linux systems, Physics is becoming as diverse in computing as its human environment.

Housing two computer labs with a third on the way, the Department of Physics is aggressively pursuing measures to meet the needs of the many users. In coordination with the IBM SUR grant, Physics is host to one of Penn State's High-Performance Computing Classrooms, which runs on a dual server system powering thirty AIX workstations with many software applications. This classroom is available for instructional use and is used by the Departments of Physics, Mathematics, Astronomy and Astrophysics, and Computer Science.

The Department of Statistics maintains a network of more than forty Sun SPARCstations and more than forty PCs. The department has two computer labs one for UNIX research computing, one for PC/NT and

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course instruction. Most faculty and graduate student offices are equipped with at least one workstation connected to the department LAN. Most major statistical software packages, including MINITAB, SAS, S-Plus, and XLispStat, are supported on the network. Other supported software packages include TeX and LaTeX, Mathematica, FORTRAN, C, IMSL, and MS Office.

Many colleges operate computing laboratories that provide students and faculty with microcomputing capabilities and/or batch and interactive access to the University's principal computers in the Center for Academic Computing.

Intercollege—The *Applied Research Laboratory* uses a network of DEC VAX, Sun, and IBM workstations, with software supporting graphics, interactive problem solving, and text processing. Uses include real-time data acquisition and data analysis for the water tunnel, acoustic tank, etc.

The *Materials Research Laboratory's* computer facilities include VAX, Sun, PC, and Macintosh workstations and Novell servers. These are part of a network utilizing Internet, Netware, and LocalTalk protocols. The network spans the various buildings of the IMRL with fiber optic links. Most offices have computers, and there are networked printers in each of the office support staff's areas. General use computer facilities are also available for any of the IMRL staff and students. Most of the equipment at the IMRL utilizes computers as an integral part of control and analysis.

GRADUATE LIFE

Current graduate enrollment at University Park Campus is about 6,300 students, of whom 68 percent are engaged in graduate study full time, 44 percent are women, and 43 percent are residents of Pennsylvania. (Undergraduate enrollment at University Park exceeds 34,000.) International students make up about 27 percent of the graduate student population, and about 9 percent of enrolling graduate students report themselves as members of recognized U.S. ethnic minority groups.

University Park campus is one of the most naturally beautiful American campuses. On any given day of the semester, about 50,000 people will be on the campus: 38,000 students, 12,000 employees, and several hundred visitors. Although the size of the campus can be intimidating, graduate students soon find that its size and diversity afford a variety of stimulating activities. This variety reflects the University's view that a person's graduate experience should include, in addition to course work and research, living in a scholarly atmosphere, profiting from the perspectives of visiting scholars and artists, and engaging in informal discussions with faculty and fellow students. It also should mean participating in student affairs and University governance, and allowing time to reflect, to explore fields related to one's specialty, and to enjoy leisure activities.

Although the mailing address of the largest campus is University Park, PA 16802, this name ordinarily does not appear on maps. The University Park campus is located in State College, Pennsylvania, an area with a population of more than 72,000. State College is located on U.S. Highway 322, near Interstate 80, and can be reached directly by bus or airline service. The town retains a collegiate atmosphere enhanced by many small shops, restaurants, cinemas, and bookstores.

GRADUATE STUDENT ASSOCIATION

The Graduate Student Association (GSA), established in 1951, is the representative body for graduate students, all of whom are automatically members. The mission of the GSA is to represent and support the interests of the University's current and future graduate student community by supporting scholarly activities and providing leadership, service, and social opportunities. This volunteer organization, recognized by the University as the graduate students' central organization, provides services, such as graduate student orientation; programs and workshops on topics including income tax issues; student advocacy on pertinent issues; a Blue Cross/Blue Shield insurance plan; social activities, such as free movies; and publications such as *The Guide to Graduate Life*, a monthly newsletter, a *Tax Guide*, a babysitters listing, and a health insurance pamphlet. The GSA is also charged with designating graduate student representatives to a number of committees throughout the University, thus maintaining contact between the graduate students and the many offices of the University.

The governing body of the organization consists of three branches: the Assembly, the Executive Board, and the Judiciary. The Assembly consists of delegates from every graduate department or program. Also included are the graduate students who have been elected to serve on the University Faculty Senate (one) and the Graduate Council (five), and University Park Allocation Committee (six), who may be nonvoting, ex-officio members unless they are also official departmental delegates. All members of the University community are invited to attend the regular Assembly meetings, which are held twice a month. An Executive Board, which consists of the president, vice president, treasurer, executive secretary, representatives from the Graduate Council and Faculty Senate, director of public relations, and Judiciary

Committee chair, has interim powers to conduct business not requiring the specific action of the Assembly. The Judiciary Committee consists of a chair and five members appointed by the president and approved by the Assembly.

Members of the Assembly are required to sit on a committee in one of the five working divisions: academics and issues; finance and fund-raising; human diversity; programming services; and publicity and publications; or on an external committee. Any student, graduate or undergraduate, is welcome to serve on any of GSA's standing committees: academics, community service, garden, *Guide to Graduate Life*, housing, income tax, diversity concerns (international, minority and women's issues), social (activities coordinator), and judiciary. Ad hoc committees are often formed to address particular issues.

GSA maintains communication among its members through its monthly newsletter, the *Daily Collegian*, scheduled meetings, and informal use of the Kern Graduate Commons. The GSA also maintains a page on the Web (<http://cac.psu.edu/~gsa/>) and a listserv to inform graduate students of current issues and events. GSA publishes annually the *Guide to Graduate Life*, an informal introduction to both the University and the community.

The Graduate Student Association office is at 111B Kern, (814) 865-4211, and is open from 9:00 a.m. to 5:00 p.m. Monday through Friday. Graduate students are encouraged to take questions or suggestions about graduate life to the office.

GRADUATE SCHOOL ALUMNI SOCIETY

The Graduate School Alumni Society (GSAS), established in 1996, is an organization of the alumni of graduate programs from across the University. The mission of the GSAS is to support education at Penn State and to connect graduate alumni to the University and to each other. The GSAS seeks to assist current graduate students in their research, teaching, and career planning through the development of programs and activities that foster interaction among GSAS members and current graduate students and through efforts to enhance fellowships, assistantships, and other forms of support.

The Board of Directors of the GSAS comprises fifteen members. All must be graduates of a Penn State master's or doctoral degree program and all serve six-year terms. Officers, who serve one year in their positions, are the president and vice president, elected by the board, and the executive secretary, an ex-officio representative of the Graduate School. The board holds three meetings per year, with at least one meeting held at a site away from University Park.

The GSAS maintains communication among its members through the distribution of *Research Penn State*, sponsorship of social events for graduate alumni held in various parts of the country, and a Web page (http://www.gradsch.psu.edu/gs_postgrad/gs_postgrad.html).

KERN GRADUATE COMMONS

The Graduate Commons, located on the first floor of Kern Building, is part of the University's Office of Student Affairs and is administered by the Office of Student Unions. It provides facilities, programs, and services for the graduate community and serves as a common meeting area for faculty and students. The assembly room and multipurpose rooms are used for large lectures, meetings, receptions, and social events; the smaller rooms are used for committee meetings and similar small-group meetings. These normally are reserved by graduate student organizations, University academic and administrative units, and events of a University-wide nature.

Food service is provided by the Department of Housing and Food Services in the cafeteria and for special catered events. The lobby contains the Commons Gallery, which exhibits artwork and research displays done by students and faculty as well as exhibits from sources outside the University. The Commons also serves as the home for Graduate Student Association programs such as socials, films, concerts, and similar events. (Policy governing building use and services is determined by the Director of the Office of Unions and Student Activities who, when appropriate, consults with the Vice President for Research and Dean of the Graduate School, the Graduate Council Committee on Graduate Student and Faculty Affairs, and the Graduate Student Association.)

The Office of the Assistant Director of the Graduate Commons serves as a clearinghouse for scheduling events. Reservations, a periodicals lending service (including daily newspapers), information regarding Graduate Commons activities, recreational equipment, and information of a general nature concerning the Graduate School, the University, and the local community are available at the Graduate Commons Information Desk. The Commons is open seven days a week during each semester and during summer sessions. The operating hours are posted at building entrances. For more information, call the Information Desk at (814) 865-1878.

CENTER FOR MINORITY GRADUATE OPPORTUNITIES AND FACULTY DEVELOPMENT

The Center for Minority Graduate Opportunities and Faculty Development has two major offices to promote and support minority graduate students and faculty at Penn State. The objectives of the Office for Minority Graduate Opportunities are threefold: to increase the number of minority graduate students at Penn State through aggressive recruitment strategies; to retain students at the University until they have successfully completed all requirements for graduation; and to provide opportunities for minority graduate students' professional and personal development during their tenure at Penn State.

Under the guidance of a Senior Faculty Mentor appointed from Penn State's tenured faculty, the Office for Minority Faculty Development offers activities such as mentoring and role-modeling; peer guidance; review and counseling; exchange of information; enhancement of communication; supplemental financial support for professional activities; and coordination and support of research opportunities. These functions are designed to expand the accession and enhance the intellectual and professional growth of Penn State's minority faculty, especially junior or recently appointed faculty who are working toward tenure.

Prospective or currently enrolled graduate students and faculty who want additional information regarding minority programs should contact the center, The Pennsylvania State University, 308 Kern Building, University Park, PA 16802; (814) 863-1663/4; fax (814) 863-5368.

OFFICE OF INTERNATIONAL STUDENTS AND SCHOLARS

The Office of International Students and Scholars (ISS), a unit of the University Office of International Programs, is located along with the International Lounge in 222 Boucke. Approximately 3,000 international students from more than one hundred countries study at the various University locations. Approximately 80 percent of these students are enrolled in graduate programs.

Services of ISS include assistance with immigration matters and tax information; academic, financial, and personal/adjustment counseling; emergency loans; billing for sponsored students; assistance in dealing with embassies, consulates, and sponsoring agencies; special orientation programs; program advising; mail service; housing information; job and travel information; an international student newsletter; advising international student organizations; and sponsoring intercultural activities.

The International Lounge is a place where international and American students can meet informally and where lectures and presentations on international topics are regularly held. All students are welcome to participate in ISS activities. Announcements of events are posted regularly in the lounge. International Programs maintains a library of work/study/travel information as well as other reading materials, including dictionaries, encyclopedias, maps, arts and crafts books, and newspapers and magazines from around the world. The lounge is available for group programs upon request.

The ISS works closely with the Division of Student Programs, the Centre County Community International Hospitality Council (a local community volunteer organization), the International Student Council, and twenty-four international student organizations at the University.

The ISS is charged with the responsibility of assuring University compliance with Immigration and Naturalization Service (INS) and United States Information Agency (USIA) regulations. In this capacity, the Office of International Students and Scholars works closely with the Graduate School and with academic departments to determine the full-time academic progress and employability of each international student. Questions relating to immigration requirements or employability should be referred to ISS. Regulations pertaining to international students are, in some cases, more restrictive than those of the Graduate School or the individual academic department.

RECREATIONAL AND ATHLETIC FACILITIES

University Park has six modern gymnasiums, fifty-four outdoor and four indoor tennis courts, one outdoor and four indoor swimming pools, two eighteen-hole golf courses and a four-hole golf course, an indoor ice-skating rink, twenty-six handball and racquetball courts, sixteen squash courts, indoor and outdoor running tracks, a baseball field, lighted intramural fields for football, soccer, and lacrosse, thirty-two acres of practice fields, and a four-mile jogging course. Rooms for weight training, fencing, archery, golf, body mechanics, dance, gymnastics, adaptive exercise, and wrestling are also available. The University's Stone Valley Recreation Area (located fourteen miles from University Park) provides sailing, boating, and picnic facilities. The wooded mountain country surrounding the State College area offers outdoor recreation—swimming, boating, camping and trail packing, climbing, hiking, skiing, caving, and fishing.

THE ARTS

Each year during the fall and spring semesters, the Center for the Performing Arts brings to Penn State a wide variety of events usually available only in major cities. The performances range from Broadway

touring companies to major symphony orchestras, operas, chamber ensembles, ballets, and solo musicians. Along with innovative dance, experimental theater and multimedia performances, the center presents a jazz series and a children's series. Divided into seven subscription series or available with single tickets, the events are staged in modern Eisenhower Auditorium and historic Schwab Auditorium.

During the summer, Pennsylvania Centre Stage, the professional theatre of Penn State, produces four plays on campus. With directors, designers, actors and actresses from the University and around the country, they stage dramas, comedies and musicals from the ground up.

The University Resident Theatre Company combines professional theatre artists with student interns from the Professional Training Program and offers a year-round season of new and classical productions. The plays are presented in the Playhouse and Pavilion theatres, offering both traditional and experimental staging.

The School of Music offers regular performances and recitals including solo artists, ensembles, and full orchestral concerts. The events are presented in the Recital Hall of the Music Building, as well as in Eisenhower and Schwab Auditoriums.

The Palmer Museum of Art displays traveling exhibitions, as well as works selected from its permanent collection. Works in various media, including those of resident and student artists, are also displayed in the Zoller, Kern, Chambers, Pattee Library, and Hetzel Union Building galleries.

The Graduate Student Association and several other student organizations and interest groups regularly show classic and recent films on campus, complementing the first-run fare of the commercial cinemas in State College. The size of the institution enables student groups to sponsor concert appearances by first-rank performers.

STUDENT SERVICES

The facilities and services outlined in the following paragraphs are available to graduate students.

CAREER SERVICES

413 Boucke Building, University Park Campus

The unit provides counseling and placement services to assist students in their career development and in formulating and implementing both short- and long-range career plans. Some specific services and programs offered by Career Services are:

Intake (412 Boucke)—An intake counselor is available on a drop-in basis weekdays from 8:30 a.m. to 5:00 p.m. to answer questions on career planning or placement, and to refer students to other services and/or University offices as appropriate.

Counseling Services—Counseling staff members are available to meet with students individually and in groups to assist with issues such as clarification of career plans, job search skills, and graduate school plans. Information resources and educational programs described below often are used to help students assess their abilities, attitudes, values, and interests, and to relate these to job and career opportunities so that they can make appropriate educational and vocational plans.

Computer-Assisted Guidance and Assessment—DISCOVER and SIGI-PLUS offer broad databases about education and occupations, as well as self-exploration and decision-making exercises. Students who use DISCOVER or SIGI-PLUS can identify interests, values, and abilities relevant to the world of work; create and narrow lists of occupations based on factors of their choices; and obtain information about academic majors, many technical or graduate programs, and hundreds of occupations. Other computer-based interest and career-related personality assessments are available through the counseling process.

Outreach Programming/Seminars—Several hundred seminars and outreach programs are offered each year on a wide range of topics such as résumé writing, interview skills, job-search strategies, internships, graduate school applications, and effective use of the on-campus interviewing system. The locations of these programs are announced in the *Daily Collegian*, on posters, and in fliers. To schedule a program, individuals and groups should call Career Services at (814) 865-2377.

Career Information Center (CIC) (410 Boucke)—The CIC contains hundreds of publications and videotapes with information on occupations, internships and summer job directories, graduate/undergraduate directories, Penn State majors, employer directories and job hunting resources to assist students in pursuing a career.

The Interview Training Center (410 Boucke)—Designed to enhance students' interviewing skills, it houses a studio composed of video recording and playback equipment for conducting mock interviews. Playback units for viewing corporate and job-search training videotapes are also a part of this facility.

Placement Services—Career Services cooperates with colleges and departments of the University to assist students in implementing career plans upon graduation. Services include: (1) scheduling interviews for students with more than 1,000 prospective employers who visit the campus; (2) career fairs at which

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students can talk to employers about job opportunities; (3) notebooks of employment opportunities for which a student may apply by mail; (4) a list of career-related summer jobs and internships; (5) workshops on interviewing skills and résumé preparation; (6) a variety of informational meetings and publications; and (7) access via telephone to the LION JOBLINE, a telephone-based vacancy listing service; and (8) access via the World Wide Web to JobTrak.

Placement Library (413 Boucke)—Contains information on approximately 1,300 organizations. Information on state and federal government employment, handouts about career-planning and job-search strategies, and notebooks containing immediate openings are available.

Education Career Services (ECS) (408 Boucke)—Students and alumni seeking teaching or administrative positions in elementary, secondary, or higher education can register in 408 Boucke with Education Career Services. Copies of credentials are sent to schools at the candidate's request. Registration for the first year is free for students and \$35 per year thereafter. The first five copies of the file are sent at no cost; the cost of additional mailings is \$3 each. ECS also will send a weekly listing of job vacancies in education if provided with self-addressed, stamped, business-size envelopes. This list is also available on Career Services' Web page at www.psu.edu/cdps. Brochures from Pennsylvania schools and out-of-state schools are also available. Career counselors are available to students by appointment to discuss planning a career in education.

Services Available to Alumni—Most of the services described above are also available to Penn State alumni. Specifically, alumni who visit our facilities at University Park campus may use the following services: intake assistance; individual career counseling (available for the first three months after graduation); DISCOVER and SIGI PLUS (available on a drop-in basis); on-campus recruiting (note information below); seminars; career fairs; placement library; vacancy listing; and educational career services.

The On-campus Recruiting System is available only to those alumni who can use the system as it is designed for current students. No mailings or phone calls are made to alumni regarding on-campus recruiting.

CENTER FOR COUNSELING AND PSYCHOLOGICAL SERVICES (CAPS)

The Center for Counseling and Psychological Services (CAPS) provides group and individual counseling, crisis intervention, and psychological and psychiatric evaluations for full-time undergraduate and graduate students, as well as prevention and consultation services for the entire University community. Students wishing an appointment may call 863-0395 or come by room 221 Ritenour between the hours of 8:00 a.m. and 5:00 p.m. Students experiencing an emotional crisis may call CAPS during its regular business hours or the Community Crisis line at 234-3337 after hours. In addition to working directly with students, CAPS offers educational programs of general interest to the University community. Consultation with faculty, staff, and students on mental health matters (e.g., counseling referrals, concerns about a roommate, or a student in class) is available by appointment or phone.

OFFICE FOR DISABILITY SERVICES

Penn State encourages academically qualified students with disabilities to take advantage of its educational programs. It is the policy of the University not to discriminate against persons with disabilities in its admission policies or procedures or its educational programs, services, and activities.

The University is responsible for ensuring that courses, programs, services, jobs, activities, and facilities are available and usable in the most integrated and appropriate settings. Student with disabilities seeking accommodations must identify as an individual with a disability and demonstrate and/or document (from an appropriate professional) how the disability limits their participation in courses, programs, services, jobs, activities, and facilities. Upon receipt of documentation of a disability, it is the responsibility of the Office for Disability Services to explore and facilitate reasonable accommodations, academic adjustments and/or auxiliary aids and services for individuals with disabilities in courses, programs, services, jobs, activities, and facilities.

Students anticipating the need for individual accommodations, both before and after enrollment, are encouraged to contact the Office for Disability Services at University Park campus (105 Boucke, 814-863-1807 v/TTY) or the director of student affairs at other Penn State locations.

HEALTH INSURANCE

Injury and sickness insurance underwritten by Mega Life and Health is available to registered undergraduate students taking 3 or more credits and graduate students taking 1 or more credits, their spouses, and eligible children. Information and applications are available at the Student Insurance Office, 320 Grange Building, University Park, PA 16802 (814-865-7467). In addition, Blue Cross/Blue Shield health

insurance is available through the Graduate Student Association at group rates for graduate students, undergraduates taking 6 or more credits, and postdoctoral students and dependents. Information about the Blue Cross/Blue Shield plan is available from the Graduate Student Association, 111B Kern Building, University Park, PA 16802 (814-865-4211).

International students, their spouses and children, and all graduate assistants and full-time graduate Fellows are required to have health insurance that meets certain criteria established by the University Student Insurance Committee. These students must show proof of health insurance at the Student Insurance Office, or they may purchase the Penn State Student Injury and Sickness Insurance Plan.

The University contributes 80 percent of the premium for graduate assistants and full-time graduate Fellows enrolled in the plan administered through University Health Services' Student Insurance Office. Any spouse/child coverage is the responsibility of the student.

UNIVERSITY HEALTH SERVICES

University Health Services has clinics located in the Ritenour Building and Johnston and Shulze Halls on the University Park campus. Its facilities are available to all students registered for the current semester and spouses enrolled in the Student Injury and Sickness Insurance Plan.

Primary-care physicians, nurse practitioners, and physician assistants diagnose and treat acute illnesses and injuries. Appointments can be made to see any primary-care practitioner. Primary-care practitioners also provide continuing care for chronic medical conditions. The General Medicine Department is open from 8:00 a.m. to 5:00 p.m. Monday through Friday, except Wednesday, when the hours are 9:00 a.m. to 5:00 p.m.

Urgent care is available during selected hours. University Health Services maintains an ambulance service for local transportation of students with nonambulatory illnesses and injuries. Persons with life-threatening illnesses or injuries should go directly to the Centre Community Hospital Emergency Room.

University Health Services has a clinical laboratory, X-ray and physical therapy departments, a pharmacy, and a nutrition clinic. Health promotion opportunities are made available to all students by the Office of Health Promotion and Education. Workshops are sponsored and individual consultations are provided to address such topics as alcohol, nutrition, sexual health including contraception, and self care as well as general health promotion and wellness.

The Women's Health Department offers examinations, contraceptive services, treatment of gynecological problems, pregnancy testing, diagnosis and treatment of sexually transmitted disease, and evaluation, treatment, counseling and referral for victims of sexual assault or other forms of violence.

All basic clinic visits are \$14. This fee covers most supplies and procedures performed at University Health Services. Laboratory tests, X-rays, physical therapy treatment and pharmacy are separate charges. Payment must be received within seven days after treatment. The University accepts payment by cash, check, or credit card (VISA, MasterCard). Spousal charges cannot be charged to the student account. For additional information on available services, visit the UHS Web site at <http://www.psu.edu/UHS>.

Penn State Erie—The Behrend Health and Wellness Center is oriented around a comprehensive health care approach. Various wellness and preventive health programs are sponsored by the center throughout the academic year at no charge to students, faculty, and staff.

The center is staffed by a full-time certified nurse practitioner who is licensed to provide health education, assessment, and treatment of minor illnesses and related health problems. Registered nurses, a part-time physician, and a wellness coordinator complete the health care team.

All services provided by the Health and Wellness Center staff are completely confidential. In keeping with University policy, excuses for class absences are not provided.

Penn State Harrisburg—Health services at Penn State Harrisburg are provided by nurses and a part-time physician. Primary care and health education are offered to all students at no charge. All services are confidential.

HOUSING AND FOOD SERVICES

Eastview Terrace and Graduate Circle, both located on the eastern side of campus and within comfortable walking distance of most of the campus, provide one- and two-bedroom apartments for single students or students with families.

The Eastview Terrace apartments are fire-resistant, steel-framework, one-story buildings. There are thirty-eight one-bedroom units and twenty-six two-bedroom units. Rent includes water, television cable, and basic telephone service. Tenants pay for electricity, gas, and local and long distance telephone calls. Water is heated electrically. The units are unfurnished except for electric stove and refrigerator. For every

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two units, a utility room with two stationary laundry tubs and storage space is provided. Washers and dryers are not permitted. Card-operated laundry facilities are available.

Graduate Circle has 144 one-bedroom apartments and 72 two-bedroom apartments in sixteen two-story buildings of brick and frame construction. Rent includes all utilities (and TV cable) except for telephone. Card-operated laundry facilities are available. Each kitchen has a double stainless-steel sink with disposal unit, a gas stove, kitchen cabinets, and an electric refrigerator. One-bedroom apartments have a built-in chest of drawers; otherwise, the units are unfurnished. There are no facilities for private washing machines in the apartments; however, card-operated laundries at nominal fees are provided in five of the buildings throughout the area. A basement storage locker is provided for each apartment.

Residence in Graduate Circle or Eastview Terrace University apartments is limited to registered full-time students. All students must live with their spouses and/or children younger than eighteen in the apartment. The one-bedroom units are designed for a student and/or spouse, and the two-bedroom units for a family with not more than three children. Rates and additional information can be obtained from the University Apartments, The Pennsylvania State University, 516 Elm Road, Eastview Terrace, University Park, PA 16802; (814) 865-7671.

The Nittany Apartment complex on the University Park campus houses single students. Two styles of apartments are available to graduate students, and each apartment accommodates four students. Two-story townhouse apartments have two bedrooms and a full bath upstairs, two bedrooms, a half bath and a living/dining room area, and kitchen on the first floor. Garden apartments have four bedrooms, a full bath, living/dining area, and kitchen all on one floor. Each apartment is designated for occupancy by one gender.

Apartments are heated and air-conditioned by a heat-pump. Residents are charged monthly for their portion of the electric bill for their apartment, which includes hot water, lights, appliances, heat/air conditioning, etc. Residents are expected to provide their own sheets, blankets, pillows, towels, cooking and eating utensils, television set, and telephone. Television cable service and local phone service is provided to each bedroom and residents are billed for long distance and off-campus telephone calls.

McKee Hall is a traditional residence hall for graduate students, located near Kern Building on the University Park campus. Room and board or room only contracts are available for single graduate men and women. New students are assigned to double-rooms with another graduate student of the same gender. All residence hall rooms are nonsmoking and have television cable service. Separate computer Internet (ethernet) cable access for each student is provided in the room rate. Phone service and telephones are provided, with long-distance and local calls billed to the residents.

Diners Club and A La Board meal plans are optional and available to graduate students living on and off campus. Dining facilities located in residence hall commons buildings and eateries located in the Hetzel Union Building and Kern Building accept either meal plan points or cash and offer full service including hot meals, deli selections, vegetarian entrees, salads, frozen yogurt, and other selections.

Rates and further information regarding Nittany Apartments, McKee Hall and meal plan options are available through the Assignment Office for Campus Residences in 101 Shields Building (814) 865-7501.

Academic Year 1998-99 Rates

Nittany Apartments/per semester/per person*	\$1,450/Garden	\$1,525/Townhouse
McKee Hall/per person double-occupancy**	\$1,255/semester	
A La Board Meal Plan (full plan)	\$1,065 (plan 1) to \$1,330 (plan 6)	

*Does not include electricity

**Rate for room without a meal plan

Information on other living accommodations available in the community can be obtained through:

- Graduate Student Association
- The Pennsylvania State University
- 111 Kern Building
- University Park, PA 16802
- (814) 865-4211
- Organization for Town Independent Students
- The Pennsylvania State University
- 101B Hetzel Union Building
- University Park, PA 16802
- (814) 865-6851
- Chamber of Business and Industry of Centre County
- 200 Innovation Blvd.
- State College, PA 16803
- (814) 237-7644

Graduate students should arrange for their accommodations well in advance of the beginning of classes, because it may be very difficult to find convenient housing at the last minute. *Students must be admitted to the Graduate School before their requests for on-campus living accommodations can be processed.*

VETERANS OUTREACH OFFICE

The Veterans Outreach Office, 325 Boucke, provides information on programs and services unique to veterans. (See Veterans' Benefits.)

TUITION AND CHARGES

TUITION AND CHARGES 1998–99

The University reserves the right to revise the schedule of tuition and charges without further notice. Tuition rates for 1998–99, shown below, are rates for one fifteen-week semester of study under an academic calendar consisting of two fifteen-week semesters and an eight-week summer session per calendar year. The tuition figures shown may be changed for future academic years. Check the Bursar's Web page at www.bar.psu.edu for up-to-date information.

With reference to tuition, the primary campus of a student determines the rate assessed regardless of the location of a course.

Tuition is the same for courses whether audited or taken for credit. Any student who does not fulfill payment obligations promptly may be charged a late payment fee of \$25. A student whose account is delinquent for more than ten days is subject to suspension from the University.

TOTAL TUITION FOR EACH SEMESTER IN 1998–99

University Park Campus and the Milton S. Hershey Medical Center (Nonmedical Students)—12 or more credits, \$3,267 for Pennsylvanians and \$6,730 for non-Pennsylvanians; 11 or fewer credits, \$276 per credit for Pennsylvanians and \$561 for non-Pennsylvanians. These rates apply also for off-campus research and other approved individual study. At University Park, total M.B.A. tuition is \$3,608 for Pennsylvanians and \$7,070 for non-Pennsylvanians; 11 or fewer M.B.A. credits, \$305 per credit for Pennsylvanians and \$591 for non-Pennsylvanians.

Penn State Erie and Penn State Harrisburg—12 or more credits, total charge of \$3,267 for Pennsylvanians and \$6,258 for non-Pennsylvanians; 11 or fewer credits, \$276 per credit for Pennsylvanians and \$523 for non-Pennsylvanians. For the M.B.A., \$318 per credit for Pennsylvanians and \$611 for non-Pennsylvanians.

Penn State Great Valley—Tuition at Penn State Great Valley is \$343 per credit for Pennsylvanians and \$611 per credit for non-Pennsylvanians.

The Dickinson School of Law—Tuition at The Dickinson School of Law is \$7,520. Contact Dickinson directly for information about fees.

Continuing Education Courses—Tuition for continuing education courses carrying graduate credit will be charged at the prevailing rate at the campus where the courses are offered.

Pennsylvania Residency—If a student who is admitted believes that circumstances do not justify classification as a non-Pennsylvanian, a petition can be addressed to the Residency Appeals Officer, The Pennsylvania State University, 108 Shields Building, University Park, PA 16802, to request reclassification. (See Appendix V in this *Bulletin*.)

SPECIFIC CHARGES

In addition to the foregoing tuition and charges, the following charges apply under special conditions and are to be paid independently:

Application fee	\$40.00
Change of schedule (each change after first five working days of semester)	6.00
Duplicate student identification and activity card each	10.00
Music, individual lessons	100.00 to 150.00
Privilege of late payment	25.00
Privilege of late registration	10.00
Special Ph.D. thesis preparation registration fee (601, 611)	780.00
Special Ph.D. thesis preparation registration fee 601/course for audit	780.00

GENERAL INFORMATION

Special Ph.D. thesis preparation registration fee 601/course for credit	1,090.00
Student parking fee, two semesters (most locations)	105.00
Teacher placement service registration fee	10.00
Teacher placement service reactivation fee	10.00
Thesis microfilming and binding fee for master's candidate (one copy)	17.00*
Thesis microfilming and binding fee for doctoral candidate (one copy)	70.00*
Official transcript of records (with seal), each copy	6.00
Mailing diploma in absentia	5.00

Computer Fee—This is nonrefundable fee charged to **all** students. On-campus enrollments and off-campus enrollments (student teaching, Co-op programs, etc.) are subject to this fee. This fee does not apply to graduate students enrolled in courses numbered 601 through 611.

The computer fee is charged according to the number of enrolled credits immediately prior to the first day of the semester. Adding credits on or after the first day of the semester could result in a corresponding increase of the fee. Dropping credits on or after the first day of the semester **will not** reduce the fee charged.

0-4 credits	\$31.00
5-8 credits	\$65.00
9 or more credits	\$90.00

Student Activities Fee—This is nonrefundable fee charged to **all** students. On-campus enrollments and off-campus enrollments (student teaching, Co-op programs, etc.) are subject to this fee. This fee does not apply to graduate students enrolled in courses numbered 601 through 611.

The activity fee is charged according to the number of enrolled credits immediately prior to the first day of the semester. Adding credits on or after the first day of the semester could result in a corresponding increase of the fee. Dropping credits on or after the first day of the semester **will not** reduce the fee charged.

0-4 credits	\$12.00 (University Park, Erie) \$9.00 (Harrisburg)
5-8 credits	\$26.00 (University Park, Erie) \$19.00 (Harrisburg)
9 or more credits	\$36.00 (University Park, Erie) \$26.00 (Harrisburg)

Surcharge—This is a nonrefundable fee and is in addition to tuition. The surcharge is charged to upper-division and graduate students enrolled in the College of Earth and Mineral Sciences, the College of Engineering, the Eberly College of Science, the School of Architecture and Landscape Architecture, and the School of Nursing. On-campus enrollments and off-campus enrollments are subject to this fee. This fee does not apply to graduate students enrolled in courses numbered 601 through 611.

The surcharge is charged according to the number of enrolled credits immediately prior to the first day of the semester. Adding credits on or after the first day of the semester could result in a corresponding increase of the fee. Dropping credits on or after the first day of the semester **will not** reduce the fee charged.

	9 or more credits	5 to fewer than 9 credits	Fewer than 5 credits
University Park:			
Coll of Earth and Min Sci, Coll of Engr; A B E, ARCH, LARCH majors			
	\$233.00	\$140.00	\$70.00
Eberly Coll of Science; Q M M, ACS, BIOE majors			
	\$156.00	\$93.00	\$47.00
Erie and Harrisburg:			
Eberly Coll of Science			
	\$156.00	\$93.00	\$47.00
Engr & Engr Tech majors			
	\$233.00	\$140.00	\$70.00

*For doctoral theses, this fee provides for thesis abstracting and abstract publication in *Dissertation Abstracts*, microfiche production and archiving at UMI, supply of a microfiche copy to the University Libraries, and on-campus thesis binding for the Libraries' paper copy. For master's theses, this fee provides for on-campus binding and microfilming.

Altoona, Abington, Allentown, Berks, Schuylkill, Commonwealth College:

Earth and Mineral Sciences, Engineering, and Science Majors

\$156.00

\$93.00

\$47.00

TUITION ADJUSTMENT POLICY**Withdrawal****PRO-RATA ADJUSTMENT:**

- Used for students who receive federal Title IV and withdraw within the first 60 percent of their first semester at Penn State.
- Adjustment percentage based on student's last day of attendance provided withdrawal form is filed within one calendar month of last class attended
- Tuition, fees, room, and board adjusted on a pro-rated basis
- For fifteen-week course, students incur 1/15th of their charges each week of the semester rounded up to the nearest 10 percent

INSTITUTIONAL ADJUSTMENT:

- Used for all students who are not awarded federal Title IV aid
- Used for non-pro-rata federal Title IV aid recipients when the institutional adjustment percentage is greater than the federal adjustment percentage (see Federal Adjustment, below)
- Adjustment percentage based on student's last day of attendance provided withdrawal form is filed within one calendar month of last day attended
- Students incur 20 percent charge for first week of class
- Students incur additional 10 percent charge for each subsequent week
- Students incur full cost (100 percent) beginning with the ninth week

FEDERAL ADJUSTMENT:

- Minimum federal adjustment guidelines for non-pro-rata federal Title IV aid recipients
- Used for non-pro-rata federal Title IV aid recipients when the federal adjustment percentage is greater than the institutional adjustment percentage
- Adjustment percentage based on student's last day of attendance (LDOA) provided withdrawal form is filed within one calendar month of LDOA
- The federal adjustment is calculated as follows:
 - a. If the student's LDOA is prior to the beginning of class, the school must make 100 percent adjustment of the tuition charge.
 - b. If the LDOA is within the first 10 percent of the semester, then the student incurs 10 percent of the tuition charge.
 - c. If the LDOA is after 10 percent of the semester has elapsed but before the first 25 percent of the semester, then the student incurs 50 percent of the tuition charge.
 - d. If the LDOA is after 25 percent of the semester has elapsed but before the first 50 percent of the semester, then the student incurs 75 percent of the tuition charge.
 - e. If the LDOA is after 50 percent of the semester has elapsed, then the student incurs 100 percent of the tuition charge.

Examples of the implementation of the three adjustment formulas are available upon request from the Fee Assessor and the Office of Student Aid.

Adjustment of Charges of Tuition, Courses Fewer than Fifteen Weeks (Semester):

Duration of Course	Tuition-Adjustment Percentage
1 week or less	No adjustment
2–3 weeks	First week 50; second week 0
4–5 weeks	First week 70; second week 40; third week 0
6 weeks	First week 70; second week 40; third week 20; fourth week 0
7–10 weeks	First week 80; second week 60; third week 40; fourth week 20; fifth week 0
11 weeks or more	80% first week and a decrease of 10% for each week thereafter up to and including the eighth consecutive calendar week

Policy for Students Enrolled for 12 or Fewer Credits—If a student is enrolled for 12 or fewer credits and drops 1 or more credits, adjustments will be determined on the effective date of the drop, using the same adjustment percentage as listed above in the Institutional Adjustment section under Withdrawal.

If the course is less than fifteen weeks, refer to that section under Withdrawal to determine adjustment percentage.

Terms of Adjustment—The University will not release refunds of tuition, room, and board until at least three weeks have elapsed from the date the payment was received. All refunds will be made by check and mailed to the student's home address. No refunds will be made for other charges.

Requests for refunds based on withdrawal from the University should be addressed to the Office of the Bursar, The Pennsylvania State University, 103 Shields Building, University Park, PA 16802.

Deposits or deposit balances and credit balances to student accounts will be refunded to the student early in the semester following the student's withdrawal or graduation. The refund will be made by check and mailed to the student's home address that is currently on file with the University. All financial obligations of every kind, whether matured or unmatured, due and owing to the University must be completely settled before any refund is issued.

If, due to incorrect student address information, the University's attempt to forward a refund fails, the University will retain the deposit and/or the student account credit balance for one year. After one year, the refund amount will become a general gift to the University.

STUDENT AID

Graduate students may explore four separate avenues when seeking financial assistance. Most aid is awarded by the academic department in the form of graduate assistantships, the Graduate School, the Office of Student Aid, or external agencies. The process for aid consideration is decentralized; consequently, it is necessary to file applications with each office.

The deadlines for submitting financial aid applications vary with each area. Early application for financial aid is recommended because early applicants are the most likely to receive favorable consideration. It is often desirable to apply by the first week in February for the succeeding year. It is best to apply for all sources of aid simultaneously, not sequentially in order of preference. Filing sequentially may lead to missed deadlines if the first choice is unsuccessful.

The principal sources of financial assistance follow.

ASSISTANTSHIPS

Approximately 3,000 graduate assistantships are awarded annually. An appointee may serve as an assistant in classroom or laboratory instruction, in research, or in other work.

A prospective student should write directly to the person in charge of the intended graduate major program for information, and indicate on the graduate admission application an interest in receiving a graduate assistantship. The necessary application forms will then be sent by the graduate program. Appointments are made subject to the student's receipt of a bachelor's degree and admission to the Graduate School as a degree student. Clear evidence of superior ability and promise is required.

Although Penn State's classes last fifteen weeks per semester, appointments of graduate assistants are for eighteen weeks of activities per semester. Thus the duties in an academic year appointment (thirty-six weeks) such as is normally provided for teaching assistants, will begin on the Monday following the last day of summer session final exams and continue until the last day of spring semester final exams, less the period of time classes are suspended at Thanksgiving and Christmas. A forty-eight-week appointment, such as is provided for many research assistants, consists of the thirty-six-week period of the academic year plus twelve weeks for summer session activities.

Reappointment to an assistantship is based on availability of positions and the quality of the student's performance. In most departments or major programs the number of years an appointment may be renewed is limited. Unsatisfactory academic performance in any semester or summer session is sufficient cause for termination of the appointment at the end of that period. Unsatisfactory performance of assistantship duties is also sufficient cause for termination.

Legislation passed by the University Faculty Senate in 1981 and 1989 requires that all newly appointed teaching assistants participate in a TA training program unless they can provide evidence of successful prior teaching experience; and that all new international TAs take and pass a test of spoken English. Details of the procedures for meeting these requirements may be obtained by new graduate students during their departmental orientation or by contacting the Instructional Development Program, 1 Sparks Building.

Nondegree students are not eligible for assistantships.

The assistantships vary as follows (*see also* Visiting and Auditing Classes and Credit Loads and Academic Status):

QUARTER-TIME—The student normally schedules 9 to 14 credits per semester (5 to 7 in summer session), receives a stipend plus a grant-in-aid of resident education tuition, and performs tasks that, on the average, occupy approximately ten hours per week.

HALF-TIME—The student normally schedules 8 to 11 credits per semester (4 to 6 in summer session), receives a stipend plus a grant-in-aid of resident education tuition, and performs tasks that, on the average, occupy approximately twenty hours per week.

THREE-QUARTER-TIME—The student normally schedules 6 to 8 credits per semester (3 to 5 in summer session), receives a stipend plus a grant-in-aid of resident education tuition, and performs tasks that, on the average, occupy approximately thirty hours per week.

The credit load limits specified above may be increased or decreased for a specific semester by permission of the assistantship supervisor, the student's adviser, and the dean of the Graduate School, provided the total work load is properly balanced in each semester and the average credit load over an academic year is in conformity with the guidelines stated above.

A graduate assistant may accept concurrent employment outside the University only with permission from the assistantship department head and the assistant's graduate academic program chair.

FELLOWSHIPS AND TRAINEESHIPS

About 290 fellowships and traineeships are awarded annually. Recipients must be superior students and are sometimes required to have completed a certain minimum of graduate work before being eligible for an award. Fellows and trainees are required to carry at least 9 credits of course work each semester or the equivalent in research, receive stipends that vary with the awards, and usually receive grants-in-aid of tuition. They may not accept employment during the period of their appointments (except with special permission for training purposes) nor are they required to render any service to the University. In some cases, a recipient will be expected to engage in research in a broad field specified by the donor. There is no sharp distinction between a fellowship and a traineeship. Scholarly excellence is always a major consideration and usually the most important criterion in selecting fellowship recipients. Other considerations, in addition to scholarly excellence, may be taken into account in awarding traineeships.

Penn State, along with some 370 graduate institutions, subscribes to the "April 15th Resolution" of the Council of Graduate Schools. This states that acceptance of an offer of financial aid prior to April 15 is not binding up to April 15. After that, the student may not accept an offer from another institution without first obtaining a formal release from the previous commitment.

Selection of recipients of all University awards is made without regard to the sex, race, religious belief, ethnic origin, disability, or age of the applicant, as established by law.

Graduate University Fellowships—Graduate University Fellowships are awarded by the Graduate School to a limited number of scholastically outstanding incoming students. In 1998–99, Fellows received stipends of \$13,000 and payment of tuition. Fellows are required to enroll as full-time students. For incoming students, the graduate admission application serves as the fellowship application. Applications must be submitted through the applicant's graduate major program and must be received by the Graduate School no later than February 15 to be considered for the following year. Graduate Record Examination verbal, quantitative, and analytical test scores, or other accepted test scores approved by the dean of the Graduate School, are required of all applicants.

The Graduate School also administers the Academic Computer Fellowship Program. Interested students should contact their departments or the Fellowship Office concerning their eligibility.

Minority Graduate Scholars Awards—These are fellowships, assistantships, and fellowship supplements granted to incoming students as a part of the University's comprehensive educational opportunity program. The graduate admission application serves as the Minority Graduate Scholars application and must be submitted through the applicant's graduate program; the program must guarantee funding for the second year before an award for the first year is made. For more information, contact the Graduate School Fellowship Office, 313 Kern; http://www.gradsch.psu.edu/gs_overview/gs_fellowships.html.

External Fellowships and Traineeships—More than 200 such awards, with various stipends, are granted through individual departments and state and national organizations. These awards are shown with the pertinent graduate program description under Graduate Programs, Faculty, and Courses in this *Bulletin*. Information and application forms can be secured from the person in charge of the appropriate graduate program. Specific awards will vary somewhat from year to year.

GENERAL INFORMATION

In addition, grants are available from governmental agencies, industrial concerns, foundations, and the armed forces for graduate study and frequently for support of investigations of particular problems. Detailed information can be secured from the department of specific interest. Information on external funding opportunities is available in the reference areas of the libraries. The Graduate School Fellowship Office's Grants Center helps students search for external funding. Identifying potential sources and assisting with student applications/proposals are two of the main functions of this center. Two resources have become available on the Internet to assist students in their search for external funding. FASTWEB enables students to customize their own searches using multiple criteria (the Net site is <http://web.studentservices.com/fastweb>). SPIN provides a breakdown of funding opportunities by discipline and deadline date. For SPIN, <http://infoserv.rtt.net.psu/gis> is the Net site.

OTHER AID

Graduate School Tuition Grants-in-Aid—A number of grants of tuition remission for a semester of full-time study are awarded each year. Applications are available to any graduate degree or certificate student during or after the second semester at the University. Financial need is the criteria for selecting recipients. A recipient must take at least 9 credits of graduate work. Summer session tuition grants-in-aid are also available. Application forms and information on application deadlines can be obtained from the Graduate School Fellowship Office, 313 Kern. The Net site is: http://www.gradsch.psu.edu/gs_overview/gs_fellowships.html.

Employment and Loan Programs Available through the Office of Student Aid—Any prospective or current graduate degree candidate who is a U.S. citizen or permanent resident may seek aid from the federally funded loan and employment programs. Applications can be obtained from 314 Shields.

To be considered for these aid programs, a prospective graduate student must file, by February 15, a need analysis document. The Free Application for Federal Student Aid is the preferred form for Penn State.

In order to be considered for any of the federal aid programs (the Federal Perkins Loan, Federal Work-Study, or the Federal Stafford Loan), a Financial Aid Transcript must be submitted by all students who have attended an institution other than Penn State whether or not aid was received. Financial Aid Transcript forms are available through the Office of Student Aid, 314 Shields, or the financial aid office at your prior institution.

On-time applications receive first consideration. Because funds are limited, applications filed after the deadlines are considered only as funds permit. Aid is never automatically awarded for subsequent years. Students must reapply each year for funds. Students planning to attend during the summer must file separate applications.

THE FEDERAL PERKINS LOAN PROGRAM makes low-interest loans available to students with a documented financial need.

THE FEDERAL STAFFORD LOAN PROGRAM provides low-interest loans to students enrolled on at least a half-time basis. The loans are repayable after the student graduates or terminates his or her education. This federal financial aid program is a cooperative effort of the federal government, state government and/or guarantor agency, a commercial lending institution, and the educational institution. An application should be obtained from a lending institution that agrees to participate with the student in this program. All students must file a Need Analysis document to determine their financial need for these funds. Additional information about this process and about the Higher Education Loan Plan can be obtained from the Office of Student Aid.

THE FEDERAL WORK-STUDY PROGRAM is a part-time employment program awarded to students who show a documented financial need. Responsibilities and assignments are similar to those associated with graduate assistantships. This type of aid is rarely available to a student who accepts a graduate assistantship because of the difficulty of holding two jobs concurrently and the potential for a student's total aid resources to exceed his or her documented financial need.

UNIVERSITY LOANS are funds established by University organizations, alumni, faculty, staff, and friends to help students who have a documented financial need. Repayment begins after graduation or termination of study.

NONDEGREE STUDENTS—Financial aid is available for graduate students who are degree, provisional, and certificate students only. Nondegree graduate students are *not* eligible for assistance.

FEDERAL STUDENT ASSISTANCE SATISFACTORY ACADEMIC PROGRESS STANDARD—Satisfactory academic progress must be maintained for continued consideration for federal financial assistance at Penn State. Students must comply with the following to ensure continued consideration:

1. Meet minimum standards for satisfactory scholarship as established by the University Graduate Council presented in the Penn State *Graduate Degree Programs Bulletin*.
2. Meet minimum semester earned-credit-level expectations as published in the current Penn State *Policies and Rules*. (Copies of the academic standards are available in handbook form from the Office of Student Aid.)
3. Complete the requirements for the graduate degree within the time frame as indicated in the *Graduate Bulletin*.

Additional information concerning matters such as reinstatement of aid, course audits, deferred grades, and course repeats can be obtained by contacting the Office of Student Aid, The Pennsylvania State University, 314 Shields Building, University Park, PA 16802.

GUIDELINES FOR TOTAL ALLOWABLE RESOURCES

Fellowships and assistantships are offered with the provision that permission must be granted from the first awarding department/agency before a second fellowship or assistantship can be held simultaneously. Federal aid recipients are under federal regulations.

If a student receives a Federal Stafford Loan, a Federal Perkins Loan, or a Federal Work-Study job, federal regulations require that the total financial aid resources not exceed the student's documented need. If the total aid exceeds the need figure, adjustment of federal and/or University funds may be necessary. If an adjustment is not possible because the funds have been used by the student, an overaward results. In the case of an overaward, a student may be required to repay federal and/or University funds that exceed the documented need. Students with graduate assistantships or fellowships who receive federal aid during the same academic year (including summer) should be careful to adhere to these regulations. For additional details on these programs, contact the Office of Student Aid, The Pennsylvania State University, 314 Shields Building, University Park, PA 16802.

Student Employment—Many students depend upon part-time employment to help meet their expenses. Students must recognize the time demands of their work schedules and adjust their academic loads accordingly. The Office of Student Employment, 314 Shields, offers assistance in finding part-time employment in the State College community, as well as on campus. This office assists students in finding summer employment. The Office of Student Aid coordinates the Federal Work-Study program, described under Loans and Employment Programs.

Local placement services and the University Office of Personnel maintain files of positions open to spouses of students.

A student holding a fellowship or traineeship may not accept employment of any kind for service without special advance approval. A graduate assistant may accept concurrent employment outside the University only after obtaining permission from the department head and person in charge of the major program.

Concurrent appointments with the University other than a Fellowship Supplement normally may not be held.

Veterans' Benefits—The coordinator of veterans programs has the responsibility of handling all applications for benefits under the various public laws. Veterans who intend to enroll at the University should contact the Veterans Outreach Office, The Pennsylvania State University, 325 Boucke Building, University Park, PA 16802; (814) 863-1798, as far in advance as possible to obtain information and necessary forms. The Outreach Office also provides information on other programs and services unique to veterans.

Federal law and Veterans Administration regulations specify the conditions under which veterans, reservists, and eligible dependents of veterans are paid VA educational benefits. Veterans Administration benefits are paid under the federal standards of academic progress and policies relating to student conduct contained in this *Bulletin* and that apply to all graduate students. In addition, payment of VA educational benefits requires the following:

1. Courses that do not meet graduation requirements in the student's approved major (the major that the student has declared to the VA) cannot be computed as part of the student's course load for payment of VA benefits.
2. Unless mitigating circumstances exist, VA benefits cannot be paid for attendance of any portion of a course or semester that is not completed.
3. Unless specific documentation of an identifiable professional or academic goal can be provided (e.g., teachers requiring 24 graduate credits to obtain permanent certification), no veteran, reservist, or eligible dependent may be certified for payment of VA educational benefits for more than two enrollment periods in a nondegree status.

4. Since a 3.00 cumulative grade-point average is required for graduation, veterans who are graduate students, reservists, and eligible dependents will be warned that their VA educational benefits may be suspended if their cumulative grade-point average falls below 3.00 during any given semester. If the student's average remains below 3.00 for a second consecutive semester, the VA certifying official will request a determination of whether progress has been satisfactory from the appropriate department head. If it has not, the VA certifying official will suspend benefits and report the veteran to the VA for lack of satisfactory progress.
5. Veterans, reservists, and eligible dependents must report any change in academic status (change of credit load, change of major, etc.) to the Office of Veterans Programs or other appropriate VA certifying official promptly and personally.

APPLICATION AND ADMISSION PROCEDURES

STATEMENT OF NONDISCRIMINATION

The Pennsylvania State University is committed to the policy that all persons shall have equal access to programs, facilities, admission, and employment without regard to personal characteristics not related to ability, performance, or qualifications as determined by University policy or by state or federal authorities. The Pennsylvania State University does not discriminate against any person because of age, ancestry, color, disability or handicap, national origin, race, religious creed, sex, sexual orientation, or veteran status. Direct all inquiries regarding the nondiscrimination policy to the Affirmative Action Director, The Pennsylvania State University, 201 Willard Building, University Park, PA 16802-2801; tel. (814) 865-4700/V, (814) 863-1150/TTY.

ADMISSION

Each step of the educational process, from admission through graduation, requires continuing review and appropriate approval by University officials. The University, therefore, reserves the right to change the requirements and regulations contained in this bulletin and to determine whether a student has satisfactorily met its requirements for admission or graduation, and to reject any applicant for admission for any reason the University determines to be material to the applicant's qualification to pursue higher education. An applicant for admission to the Graduate School should understand that graduate work is not a simple extension of an undergraduate program but, rather, demands scholarship of a higher order, and emphasizes research, creativity, and professional competence with a minimum of formal requirements and a maximum of student initiative and responsibility.

Objective—The objective of the admission process of the Graduate School is to identify and admit a qualified graduate student body up to the limit of the University's resources to provide outstanding graduate programs. In most programs, a student may begin graduate work in the fall or spring semester or in the summer session.

As at all universities, Penn State's staff, facilities, and other resources are limited, so that not all qualified persons can be admitted. The number accepted will vary by program and from semester to semester. In some graduate programs all vacancies will have been filled long before the deadline for submitting applications, so that even outstanding students cannot be accepted.

Application—Applicants interested in graduate programs offered at the University Park Campus or The Milton S. Hershey Medical Center should apply to University Park. Those interested in programs at Penn State Harrisburg, Penn State Great Valley, or Penn State Erie, The Behrend College, should apply directly to the appropriate campus. Students normally are expected to begin work at the campus to which they are admitted. (Addresses are listed in this *Bulletin* under Program Locations.)

Qualifications—For admission to the Graduate School, an applicant must have received, from an accredited institution, a baccalaureate degree earned under residence and credit conditions substantially equivalent to those required by Penn State. (Penn State is accredited by the Middle States Association.) Ordinarily, an entering student must have completed in a satisfactory manner a minimum of course work in designated areas, the specific courses and amount of work depending upon the intended field of advanced study. Scores on the Graduate Record Examination (GRE) General Test are required by most programs. Individual program requirements for admission are included in this *Bulletin* under the specific program descriptions. Information about GRE publications can be obtained by calling the Educational Testing Service in Princeton, New Jersey, USA at (609) 771-7670 or write to GRE, Educational Testing

Service, P.O. Box 6000, Princeton, NJ USA 08541-6000. If you prefer, you may send an e-mail to gre-info@ets.org or order publications through the Web site at <http://www.gre.org>.

A baccalaureate degree holder with a slight deficiency in undergraduate preparation occasionally may be admitted and allowed to schedule a limited number of undergraduate courses to remove the deficiency while proceeding in the graduate program. Courses taken for this purpose do not apply toward the requirements of the advanced degree.

Provisional admission may be granted to applicants whose credentials are not complete at the time of application because the baccalaureate degree has not yet been conferred, grades for the current semester are not yet available, etc. Such admission is subject to cancellation if the complete credentials, on arrival, do not meet the requirements for admission. In the interim, certification of any earned credits will be withheld. If admission is canceled for any reason, the student is dropped automatically from the Graduate School. Completion of admission in such cases is dependent upon receipt of the missing credentials. (*See Provisional Admission under Classification of Students.*)

Admission is granted jointly by the Graduate School and the department or graduate program in which the student plans to study. The establishment of standards by which applicants are admitted is a departmental or program responsibility. Although the Graduate School has no fixed minimum grade-point requirement for admission, an applicant is generally expected to maintain a junior-senior grade-point average of at least 2.50 on Penn State's grading scale of A (4.00) to D (1.00). Individual programs often establish higher grade-point average requirements and use other criteria to judge candidates for admission. In exceptional cases, departments or major programs may also approve admission by reason of special backgrounds, abilities, and interests. Departmental or program requirements are given in the descriptive statements appearing under the graduate programs listed in the latter part of this publication.

A student who has been admitted to a program in which the doctorate is offered may begin working toward that degree but has no official status as a doctoral student and no assurance of acceptance as a doctoral candidate until a candidacy examination administered by the major department or committee has been passed.

Forms—Application forms can be obtained by contacting the intended department or graduate program of study. Applicants may apply for admission to only one program at a time.

Pa. Act 34 Clearance—Applicants should note that some programs may require clearance of students participating in internships/practicums in Pennsylvania school districts. Pennsylvania Act 34 of 1985 (Criminal History Record Information) specifies that employees of Pennsylvania public and private schools must undergo background checks. School districts accepting graduate students for internships/practicums increasingly require Act 34 clearance before permitting students to begin their practicums in the district, even though they are not employees. In addition, non-Pennsylvania residents are expected to present evidence of an FBI background information check. Applicants are encouraged to contact the program to which they are applying if they have questions as to this requirement and how it may affect them.

Deadlines—Applicants should obtain application deadlines by contacting the individual graduate program. The admission process is time-consuming, so submit applications as early as possible.

Nondegree Status—If you do not intend to pursue a graduate degree, but want to take graduate-level courses for personal enrichment, professional development, permanent certification, or later want to apply for degree status, you can seek admission as a nondegree student. Appropriate application forms can be obtained from the Office of Graduate Enrollment Services (Data Entry), 115 Kern; (814) 865-3425.

Changing from graduate nondegree status to regular status requires a new admission application. If you choose to enter Penn State as a graduate nondegree student, you must realize that no more than 15 credits of course work accumulated in nondegree status can count toward a graduate degree. However, admission as a nondegree student neither guarantees nor implies subsequent admission to a degree program. You should also be aware that nondegree students are not eligible to receive fellowships or graduate assistantships and preference for courses is given to degree students. Programs control access to some courses.

Applicants for nondegree admission must have received from an accredited institution a baccalaureate degree under residence and credits conditions substantially equivalent to those required by Penn State.

Minority Students—Minority students are encouraged to apply for admission to any of the programs offered in the Graduate School. Information concerning programs and financial aid can be obtained from the chair of the graduate program, the dean of the college of the student's major interest, or from the Center for Minority Graduate Opportunities, 308 Kern.

International Students—International applicants must hold the equivalent of an American **four**-year baccalaureate degree. They must submit two certified English translations of all academic records with their application.

English Proficiency—The language of instruction at Penn State is English. All international applicants whose first language is not English or who have not received baccalaureate or master's degrees from an institution in which the language of instruction is English must take the TOEFL (Test of English as a Foreign Language) and submit the results of that test with the application for admission. A TOEFL score of 550 on the paper test or a score of 213 on the computer-based test is required for admission. The graduate program may require a higher score. Applicants with scores below but close to 550 (or 213) may be admitted provisionally upon the recommendation of the relevant major program, and allowed to fulfill the TOEFL requirement at the earliest opportunity in one of three ways: (1) by retaking the TOEFL successfully; (2) by enrolling in the Intensive English Communication Program (IECP), 301 Boucke Building, and obtaining certification; or (3) by taking Speech Communication courses 114G (Basic English as a Second Language) and 116G (English as a Second Language: Reading and Writing) and attaining a grade of A in both. Inability to meet the TOEFL standard will result in termination of a student's program without awarding of a degree.

Information about the TOEFL can be obtained by writing to the Educational Testing Service, Box 6155, Princeton, NJ 08541-6155. Local administration at University Park campus of the TOEFL is handled by the IECP.

Undergraduate Students—Any senior with a 3.50 grade-point average may be admitted to 500-level courses with the consent of the instructor; other seniors with a B average or better may be admitted to graduate courses with the consent of the instructor, the student's academic advisor, and the dean of the Graduate School. Forms to request permission to take 500-level courses are available in 114 Kern (Office of Graduate Enrollment Services).

Undergraduate student participants in The Schreyer Honors College who undertake integrated undergraduate-graduate study (IUG) can pursue concurrent bachelor's and master's degrees. Information on IUG study can be obtained at the office of the dean of The Schreyer Honors College, 214 Willard.

In certain cases undergraduate students may subsequently apply credits they have earned in 400- and 500-series courses toward an advanced degree at Penn State. After admission to the Graduate School, and with the approval of the major field, a maximum of 9 credits relevant to the graduate program of study *that were not used to satisfy undergraduate requirements* may be applied toward an advanced degree. The time limitation on the completion of a master's degree program applies to these as well as to other credits.

Postdoctoral Fellows, Scholars, and Guests of the University—Postdoctoral Fellow appointments are financed under a Postdoctoral Fellow Program of a granting agency outside the University. A Postdoctoral Scholar is the usual designation for all other postdoctoral appointments that meet the standards enumerated by the National Research Council. Postdoctoral appointments are considered appointments of a temporary nature that are intended to offer an opportunity for continued experience in research or teaching, usually, though not necessarily, under the supervision of a senior mentor.

Individuals holding the highest degree in their fields from Penn State or other accredited colleges and universities are invited to apply to the dean of the Graduate School for guest privileges for purposes of noncredit study. Guests may attend seminars and courses with the privileges of faculty members and, if space and facilities are available, carry on research. Individuals may also be appointed to temporary positions in all University ranks. All guests are expected to affiliate formally or informally with one of the departments, institutes, or other subdivisions of the University engaged in scholarly pursuits.

Policy on Second Doctorates—The Graduate School does not admit applicants to concurrent double Ph.D. degree programs, D.Ed. degree programs, or concurrent Ph.D. and D.Ed. programs. In general, the Graduate School discourages the pursuit of a second Ph.D. or D.Ed. degree. However, if an applicant who holds either of these degrees requests admission to a second doctoral degree program (either Ph.D. or D.Ed.), the applicant is asked to give the Graduate School the reason why the second doctorate is necessary (as opposed to taking course work or a master's degree in the second field). The Graduate School then may solicit responses concerning the necessity of the second doctorate from representatives of the field at Penn State or elsewhere. This information is then given to the Dean of the Graduate School for the final decision. If approved, all Graduate School requirements for the second doctorate must be met *de novo*.

Student Pennsylvania Resident Status—When it appears that an applicant for admission is not a resident of Pennsylvania for tuition purposes, a non-Pennsylvanian classification is assigned. If the student

who is thus admitted believes that circumstances do not justify classification as a non-Pennsylvanian, a petition may be addressed to the Residency Appeals Office, The Pennsylvania State University, 108 Shields Building, University Park, PA 16802 for reclassification. Penn State Harrisburg students may petition the Penn State Harrisburg financial officer.

A copy of the Policy for Determination of Eligibility for Reclassification as a Pennsylvania Resident for Tuition Purposes can be obtained in the office mentioned above and should be reviewed before requesting reclassification. Any reclassification resulting from a student's petition shall be effective for tuition purposes as of the date such petition was filed. A student who changes residency from Pennsylvania to another state must promptly give written notice to the University. See Appendix V to this *Bulletin*.

TRANSFER CREDIT

Subject to the limitations given below, a maximum of 10 credits of high-quality graduate work done at an accredited institution may be applied toward the requirements for the master's degree. However, credits earned to complete a previous master's degree, whether at Penn State or elsewhere, may not be applied to a second master's degree program at Penn State.

The student should distinguish carefully between the transferability of credit and its applicability in a particular degree program. Approval to apply any transferred credits toward a degree program must be granted by the student's academic adviser, the program head or graduate officer, and the Graduate School. Transferred academic work must have been completed within five years prior to the date of first degree registration at the Graduate School of Penn State, must be of at least B quality (grades of B- are not transferable), and must appear on an official graduate transcript of an accredited university.

Pass-fail grades are not transferable to an advanced degree program unless the "Pass" can be substantiated by the former institution as having at least B quality.

Forms for transfer of credit can be obtained from the Office of Graduate Enrollment Services, 114 Kern.

CREDIT BY EXAMINATION

Examinations to establish credit for work done in absentia or without formal class work may be used to remove undergraduate deficiencies, but not to earn credits toward an advanced degree. Arrangements are made by the student directly with the major department head or program chair.

CLASSIFICATION OF STUDENTS

A graduate student may be admitted as a degree student, a certificate student, or a special nondegree student, depending upon his or her objectives. A student who has held only nondegree status and who later wants to apply for degree status must contact the Office of Graduate Enrollment Services, 114 Kern. Admission as a nondegree student neither guarantees nor implies subsequent admission to a degree program. Any other change in classification must be arranged through the Office of Graduate Enrollment Services.

Degree Student—A degree student is one who plans to become a candidate for an advanced degree at Penn State and who has been formally admitted for advanced studies in a particular program. The program of study is developed under the guidance of an adviser appointed by the head of the student's major program. A degree student who has passed a candidacy examination is classified as a doctoral candidate.

Provisional Admission—Provisional admission is a temporary classification in which an applicant may remain for a period no longer than two semesters following admission or the time it takes to accumulate 15 credits, whichever comes first. If the deficiencies that caused the provisional admission are not corrected by this time, the student may be dropped from the program.

Nondegree Student—If you do not intend to pursue a graduate degree, but want to take graduate-level courses for personal enrichment, professional development, permanent certification, or later want to apply for degree status, you can seek admission as a nondegree student. Appropriate application forms can be obtained from the Office of Graduate Enrollment Services, 115 Kern; (814) 865-3425.

A maximum of 15 credits earned as a special nondegree student may be applied to a degree program, with departmental approval. The credits must have been earned within five years preceding entry into the degree program. Forms for transfer of nondegree credits are available in the Office of Graduate Enrollment Services, 114 Kern.

Applicants for nondegree admission must have received from an accredited institution a baccalaureate degree under residence and credit conditions substantially equivalent to those required by Penn State.

Certificate Student—A certificate student is one who is engaged in a program of study leading to a certificate or equivalent recognition of accomplishment rather than a graduate degree program at Penn State. Certificate students have the same University privileges and responsibilities as graduate degree students. (See additional information under Pennsylvania Department of Education Certificate Candidates.)

Undergraduate Student—Such a student is not a graduate student because a baccalaureate degree has not been attained. The student may not register for graduate courses (500 series) unless he or she is a senior with at least a 3.50 cumulative GPA or with at least a 3.0 GPA and special permission from the Office of Graduate Enrollment Services. Forms to request permission to take 500-level courses are available in 114 Kern, Office of Graduate Enrollment Services.

REGULATIONS AND CONDUCT STANDARDS FOR STUDENTS ENROLLED IN THE GRADUATE SCHOOL

It is the responsibility of students to be cognizant of the rules, regulations, and procedures of the University. This information is contained in the *Policies and Rules*, available from the HUB desk and each college dean's office at University Park campus, and from the Office of Student Affairs at other campuses.

MOTOR VEHICLE REGULATIONS

Each graduate student who possesses, maintains, or drives or parks a motor vehicle (including a motorcycle, motor bike, motor scooter, or any other motor-driven vehicle) on any university property is required to register such vehicle with the Parking Office, 1 Eisenhower Parking Deck, before the first day of classes. Failure to register a vehicle renders a student liable for a penalty of \$20 or a magistrate's citation for each offense.

A permit for parking on campus during the day, evening, or weekend can be purchased at the Parking Office. A more restricted permit allowing driving and parking on campus for evenings and weekends at a reduced rate. Please check with the Parking Office for permits and fees.

A graduate assistant is required to comply with student regulations concerning motor vehicles. A graduate assistant receiving any permit must present a valid driver's license and the owner's card for the vehicle. The vehicle must be owned by the student, his parent, or spouse. A *Student Parking and Traffic Regulations* booklet is available in 1 Eisenhower Parking Deck.

Bicycles—All bicycles operated on the University Park campus or in the surrounding community must be registered once each year. Expiration date is May 31. Registration can be obtained at the Parking Office, 1 Eisenhower Parking Deck, or at any parking kiosk, Monday through Friday between 8:00 a.m. and 4:30 p.m. Rules and regulations are available at the time of registration.

STANDARDS OF CONDUCT

By virtue of their maturity and experience, graduate students are expected to have learned the meaning and value of personal honesty and professional integrity before entering the Graduate School. Every student is expected to exhibit and promote the highest ethical and moral standards. A violation of such standards is regarded as a serious offense, raising grave doubt that the student is worthy of continued membership in the Graduate School community. The University Code of Conduct is found in Appendix I in this *Bulletin*. Violation of the Code may result in suspension or dismissal from the Graduate School.

Research Integrity—Graduate students are expected to adhere to the highest standards of research integrity in the conduct of their research and other educational activities. They are subject to University policy AD, 47, which applies to all University personnel engaged in research activities. This policy may be accessed electronically through the University's General University Reference Utility (GURU).

RESOLUTION OF PROBLEMS

Procedures for resolving or appealing problems in the classroom and outside it are presented in Appendix II in this *Bulletin*.

OWNERSHIP OF INTELLECTUAL PROPERTY

The University encourages faculty, staff, students and visitors to create literary, scholarly and artistic works, including textbooks. Copyright ownership of such works usually rests with the creator(s) unless generated specifically under contract to the University or other sponsor. Conversely, ownership of

publishable research, instructional materials, software, patentable products, procedures and inventions, created either on University time (employees) or in association with their appointment at the University, or where significant use of University resources was involved, rests with the University. Regulations governing the ownership of these items are covered in the University's Policy on Intellectual Property (See Policy AD-36; copies available on request.)

A University Intellectual Property Agreement (IPA) form must be completed by all students and fellows and filed with their department or program office.

REGULATORY COMPLIANCE

To ensure compliance with applicable federal and state laws, certain University activities require review and approval by appointed institutional review committees. Projects involving any of the following concerns must be reviewed and approved through the Office for Regulatory Compliance (ORC) *before the project is initiated*.

Human Subjects—The Human Subjects Institutional Review Board (IRB) reviews all University research involving human subjects. IRB approval must be obtained prior to the involvement of human subjects in any research. The IRB is a committee appointed to review research proposals for proper implementation of the ethical principles for protection of human subjects as mandated by Title 45 of the Code of Federal Regulations, Part 46. Seminars are conducted by ORC on a regular basis to aid investigators in preparing a project for IRB review.

Vertebrate Animals—The Institutional Animal Care and Use Committee (IACUC) must review and approve all uses of nonhuman vertebrate animals in any University project. IACUC review and approval is mandated by the National Animal Welfare Act. The Animal and Plant Health Inspection Service (APHIS) of the U.S. Department of Agriculture enforces these regulations through regular inspections of Penn State animal facilities and review of IACUC records. Any investigator who plans a submission to the IACUC must attend an educational seminar sponsored by ORC.

Biohazards—The University Biosafety Committee (UBC) reviews and approves the use of biohazardous agents in research involving uses of recombinant DNA, infectious agents, human blood and blood products, human fluids/tissue, or microbial toxins. The UBC also reviews and approves projects using chemical carcinogens, toxic/infectious agents, and oncogenic viruses in conjunction with animals.

Isotopes—The use of radioisotopes by University personnel is closely monitored for regulatory compliance by the University Isotope Committee in conjunction with Environmental Health and Safety (EHS) in 6 Eisenhower Parking Deck; (814) 865-6391. Anyone planning to work in a laboratory that uses radioisotopes must contact Environmental Health and Safety and arrange to attend a training session on isotope handling and safety.

Policy statements on these issues can be found in the RESEARCH ADMINISTRATION SECTION (RA 14 and RA 15) and the Safety section (SY 24) of the *University Policy Manual*. Additional information and submission forms for presenting a proposal for review are available from ORC in 212 Kern, University Park campus; (814) 865-1775 or on ORC's Web site at <http://www.research.psu.edu/orc>. [NOTE: The Milton S. Hershey Medical Center is a unique Penn State campus in that it maintains a separate IRB, IACUC, UBC, and UIC. Students conducting projects at Hershey should contact their local committees for approval of research.]

ACADEMIC INFORMATION AND PROCEDURES

It is each student's responsibility to know or seek out as needed the regulations and pertinent procedures of the Graduate School as set forth in the *Graduate Degree Programs Bulletin* and in the *Thesis Guide* and to meet the standards and requirements expressed by these regulations. Copies of the *Graduate Bulletin* are available from the Graduate Commons Information Desk, 111 Kern, or by accessing the *Graduate Bulletin* Web site at <http://www.psu.edu/academic/whitebook>; the *Thesis Guide* can be obtained at 115 Kern or on the Thesis Office Web site at http://www.gradsch.psu.edu/gs_overview/theses.html. Graduate students are encouraged to contact the Office of Graduate Enrollment Services, 114 Kern, (814) 865-1795, for guidance if they have any questions, uncertainties, or difficulties concerning any procedure or regulation of the Graduate School or any procedure or regulation of the University as it may affect them.

PROGRAMS

Major Program—A directory of programs and degrees appears at the beginning of this *Bulletin*. A student's major program is the field of primary interest and the one in which the greater portion of graduate

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work is taken. Programs are designed to prepare students to assume positions of informed and responsible authority in their fields and to contribute creatively to them. They promote not only specialization, but also breadth of scholarship, the ability to study and think independently, and familiarity with the principal techniques and important literature in the field. The research undertaken by the candidate should deal with a problem that can yield a significant contribution to knowledge.

In general, departments of the University are identified with specific major programs. Thus, Aerospace Engineering is the program of study that is offered by the Department of Aerospace Engineering. In some cases, a single department offers work in more than one degree program. For example, the Department of Mineral Engineering offers programs in Mineral Engineering Management, Mineral Processing, Mining Engineering, and Petroleum and Natural Gas Engineering. Occasionally, two or more departments within a college collaborate in offering an interdisciplinary program, such as the Neuroscience major within the College of Medicine.

Intercollege Graduate Programs—When faculty members from departments in two or more colleges collaborate in offering a graduate major, the program is designated as an intercollege graduate degree program. A committee of graduate faculty members approved by the Graduate School is responsible for administering the program under a program chair. The University currently offers more than a dozen such programs, primarily at the doctoral level. They are included and identified in the listings at the beginning of this bulletin. Students interested in these programs should contact the program chair listed in the program description in this *Bulletin*.

Special Interdisciplinary Majors—In addition to the graduate major programs listed in this *Bulletin*, special individualized interdisciplinary doctoral majors may occasionally be arranged with the approval of the dean of the Graduate School. These programs are planned, reviewed, and carried out under the supervision of appropriate interdepartmental or intercollege committees.

Because such programs are individually planned, each must be unique. A special interdisciplinary program will be considered for development and possible approval only if no existing graduate program can meet the needs of the student.

Individualized degree programs are not available at the master's degree level. Normally, a student considering an individualized interdisciplinary doctoral program should present a master's degree as one of his or her qualifications.

ADVANCED DEGREES OFFERED

The degrees of Doctor of Philosophy and Doctor of Education are conferred by the University. The Ph.D. places a strong emphasis on research. The D.Ed. strongly emphasizes professional competence in a field of education. Both require high attainment and productive scholarship.

The Master of Arts and the Master of Science degrees are academic in nature, the programs placing emphasis on basic knowledge and research. A number of professional master's degrees also are conferred: Master of Agriculture, Master of Business Administration, Master of Community Psychology, Master of Education, Master of Engineering, Master of Environmental Pollution Control, Master of Fine Arts, Master of Forest Resources, Master of Health Administration, Master of Hotel, Restaurant, and Institutional Management, Master of Landscape Architecture, Master of Manufacturing Management, Master of Music, Master of Music Education, and Master of Public Administration.

Graduate degree programs are offered at five campuses of the University: University Park (State College); Penn State Erie, The Behrend College (Erie); Penn State Harrisburg (Harrisburg); The Milton S. Hershey Medical Center (Hershey); and Penn State Great Valley (Malvern). Although programs offered at all five sites are described in this *Bulletin*, each graduate center other than University Park issues its own informational bulletin as well, which should be obtained and studied by those intending to pursue graduate work at that campus. Addresses are listed under Program Locations in this *Bulletin*.

REGISTRATION

A graduate student who is *in residence* at the University is expected to be *properly registered*. *In residence* means that the student (whether full- or part-time, whether commuting to campus or other instructional site or living nearby or on campus) is pursuing graduate credits and/or an advanced degree by (a) attending classes or seminars for credit or audit; (b) doing a thesis, term project, independent study, or similar research or scholarly work in a University laboratory or other research facility; (c) consulting in person or by other means of communication with one or more faculty members on scholarly matters, research projects, or dissertation; (d) using the library, Computation Center, or other University information resources; or (e) using other University facilities provided for graduate study.

The responsibility for being properly registered rests first with the student and secondarily with the student's adviser if the student has one (nondegree students may not). A student may register for course work or research or a combination of the two. In the case of research the number of credits shall be determined by the amount of time devoted to the investigation, with 1 credit representing approximately the equivalent of one week of full-time work. In the later stages of the program, the situation will determine the requirements for the student's registration. (*See Registration Near the Completion of a Program.*)

International Students—Since international students on an F1 or J1 visa are required by INS regulation to be *in residence*, all international students should be registered for at least one credit during each regular (fall and spring) semester, even if an exception to full-time enrollment has been approved. Students who fail to register may jeopardize their status.

Advisers—Advising is an important factor in enhancing the quality of a student's program. To assist the student in planning a coherent program and meeting all degree requirements, the head of the major department or program chair will designate a member of the faculty to serve as adviser. It is the student's responsibility to secure an adviser from the department or program and to seek a conference before each registration.

Time of Registration—Registration days are indicated in the calendar at the beginning of this *Bulletin*. A student is expected to complete registration during the officially designated period and to attend the first meeting of all classes. If this is impossible because of some emergency or unusual circumstance, the student may be granted permission by the instructor to miss a few class meetings, it being understood that work missed will be made up subsequently. Under these conditions permission may be granted through the Office of Graduate Enrollment Services for the student to register late. In general, a student who receives permission to register late will be required to reduce the course load in proportion to the length of absence.

A student who fails to complete the process of registration within the officially designated registration period will be liable for the late registration charge, regardless of when the student begins attending classes.

Continuity of Registration—A student who is a degree candidate at any of the five graduate campuses of the University and who registers there without interruption for each fall and spring semester is considered to have maintained a normal continuity of registration. A student who has been admitted as a "summers only" D.Ed. candidate (*see* D.Ed. Residence Requirements) can maintain continuity by registering each summer for the six- or eight-week summer session.

Anyone who has interrupted such a normal sequence and now plans to register for work at the University Park campus is required to apply to the Office of Graduate Enrollment Services, 114 Kern, at least one month before the time of registration for permission to resume study.

The policy may be summarized for any specific semester or session as follows:

Summer Session—Resume Study/Change of Degree or Major form required unless the student was registered for the preceding spring semester or the preceding summer session (if "summers only" student).

Fall Semester—Resume Study/Change of Degree or Major form required unless the student was registered for the preceding summer session or the preceding spring semester.

Spring Semester—Resume Study/Change of Degree or Major form required unless the student was registered for the preceding fall semester.

Withdrawal—The dropping of all academic work for which a student is registered in any semester constitutes withdrawal from the University, and changes the student's status to nondegree. An application for readmission must then be submitted and approved if the student wants to enroll for further work toward a degree.

Procedure—For each registration, it is expected that the student, in consultation with the adviser, will prepare a schedule of courses and research designed to fit individual needs and meeting the pertinent credit limits. The registration process is completed in the manner specified for all students at the University.

Under certain conditions credit may be earned for work done away from the campus. A student contemplating such work should first consult with his or her adviser and then inquire at the Office of Graduate Enrollment Services about the procedures and conditions. The student must assume responsibility for the registration process, but the operation can be handled by mail or by calling the Office of the University Registrar at (814) 863-9000 for information on telephone registration. Registration must be completed before the close of central registration at University Park campus.

A student must register for courses audited as well as those taken for credit.

GRADUATE CREDITS

Typically, a candidate for an advanced degree is required to earn a certain minimum number of credits at Penn State. Consequently, there is a limit to the number of credits that may be earned at another approved institution to meet the minimum requirements of the degree. Moreover, the department or committee in charge of a major program may require a student to do more of the work at the University than specified by the limitations set by the Graduate Faculty.

Full-time participation in graduate study involves a wide range of activities. The nature of these activities varies because of the diversity of programs throughout the University. The graduate student is responsible for ascertaining, through the adviser and/or program office, the range of total activity of his or her individual program that constitutes normal progress toward the degree.

A self-supported or fellowship student who is registered for at least 9 credits is considered to be engaged in full-time academic work for that semester. If such a student wishes to register for more than 15 credits, an exception to the normal maximum load must be granted through petition (with adviser's approval) to the Office of Graduate Enrollment Services.

Credit limits and full-time status for assistants and University employees are described under Assistantships and Credit Loads and Academic Status.

Graduate courses carry numbers from 500 to 599. Advanced undergraduate courses numbered between 400 and 499 may be used to meet some graduate degree requirements when taken by graduate students. Courses below the 400 level may not. Language courses used to meet foreign language requirements are exceptions, as are the SPCOM courses for international students.

No student is permitted to count audited credits toward the minimum credit load for full-time or part-time status.

Course-Numbering System—Courses in the series 1–399 are not listed in this *Bulletin* because they are strictly undergraduate courses and yield no graduate credit. A graduate student may register for or audit these courses in order to make up deficiencies or to fill in gaps in previous education but not to meet requirements for an advanced degree.

Courses in the series 400–499 are for upperclass students with at least a junior standing and for graduate students. Only a limited number of credits earned in these courses may be counted toward the requirements for an advanced degree. Detailed regulations concerning the restrictions are given under the specific requirements for the various master's degrees.

Courses in the series 500–599 are restricted to students registered in the Graduate School, senior undergraduate students with an average of at least 3.50, and certain other students with averages of at least 3.00 who have been granted special permission to enroll through the Office of Graduate Enrollment Services. (See the introduction to Graduate Programs, Faculty, and Courses for a more detailed description of these courses.)

The numbers 600 (on campus) and 610 (off campus) are available for credit in thesis research in all graduate major programs. The numbers 601 and 611 do not denote conventional courses but are used for noncredit special registration for thesis preparation by a Ph.D. candidate. (Note that 596 course numbers may not be used for thesis research work.) Registration under these numbers will maintain status as a full-time (601) or part-time (611) student during the interval that begins at the time the student passes the comprehensive examination and meets the two-semester residence requirement and ends at the time the doctoral committee accepts the thesis. The student may register for 601 if engaged full-time in the preparation of a thesis or for 611 if engaged only part-time in thesis preparation. Candidates for the Ph.D. degree do not receive grades for noncredit registrations (601 and 611) [See also Ph.D.—Additional Specific Requirements and the common course descriptions in the introduction to Graduate Programs, Faculty, and Courses.]

Schedule of Courses—The most current information on courses that will be offered in any specific semester is found by accessing the Registrar's Web site at <http://www.psu.edu/registrar>. It gives the number of the class, the hours at which the class will meet, the location of the class, and in some cases the instructor's name.

Visiting and Auditing Classes—A graduate student registered for a given semester who wants to attend classes without receiving credit may secure permission either to visit or to audit courses during that semester.

As a visitor, a student may attend classes with the approval of the instructor but may not claim the usual privileges of class membership, such as participating in discussion, doing practicum work, or taking examinations. Registration is not required for the privilege of visiting, and no record appears on the student's transcript.

As an auditor, a student may participate in class discussion, do practicum work, take examinations, and generally enjoy the privileges of a class member. Registration procedures and fee payment are the same as for taking the course for credit. Attendance is required. No credit is given, either on completion of the course or at a later time; however, the number of credits assigned to the course appears on the grade report and on the student's transcript. Thus, when a student receives an audit grade, the number of credits audited is shown. The symbol AU shall be used if attendance has been regular, the symbol W if attendance has been unsatisfactory.

A graduate assistant or Fellow who is required to register for a certain minimum number of credits is not permitted to count audited course credits toward the minimum credits needed. Undergraduate courses taken to meet foreign language or English requirements do count in the total credit load. The student may register for credit or audit beyond the required minimum but may not exceed the normal maximum without special permission.

CREDIT LOADS AND ACADEMIC STATUS

Graduate Assistants—Graduate assistants must be enrolled at Penn State as graduate students. More specifically, since assistantships are provided as aids to completion of advanced degrees, assistants are expected to enroll for credit loads each semester that fall within the limits indicated in the table below. Maximum limits on permissible credit loads are indicated in order to assure that the student can give appropriate attention both to academic progress and assistantship responsibilities. These considerations give rise to the table of permissible credit loads below. (*See also Assistantships.*)

Level of Assistantship	Credits Per Semester		Credits per 8-Week Summer Session	
	Minimum	Maximum	Minimum	Maximum
Quarter-time	9	14	5	7
Half-time	8	11	4	6
Three-quarter-time	6	8	3	5

To provide for some flexibility, moderate exceptions to the specified limits may be made in particular cases with the approval of the student's program head and the dean of the Graduate School. The Graduate School expects that an exception made in one semester will be compensated for by a suitably modified credit load in the subsequent semester, so that, on the average, normal progress is maintained at a rate falling within the limits above. Failure to do so may jeopardize the student's academic status. Maintenance of the established credit loads and responsibility for consequences of a graduate student's change of course load rest with the student and adviser. The course load is a factor in determining whether a graduate student is classified as a full-time or part-time student; has met residence requirements; and is eligible to hold a fellowship, traineeship, assistantship, or departmental or program appointment.

Graduate assistants whose credit loads equal or exceed the minima indicated in the table, and whose assistantship activities are directly related to their degree objectives, are considered by the Graduate School to be engaged in full-time academic work.

Full-Time Academic Status—Students holding fellowships, traineeships, or other awards based on academic excellence are required to carry 9 or more credits each semester. A graduate assistant whose semester or summer session credit load exceeds the minimum in the above credit table and whose assistantship duties are directly related to his or her degree objectives is considered by the Graduate School to be engaged in full-time academic work for that semester. A postcomprehensive doctoral candidate who is registered for SUBJ 601 also is so considered. Students carrying 5 credits in summer session are considered full-time.

Part-Time Academic Status—A student who in any semester or summer session is registered for study but who does not meet the criteria for full-time status is considered to be engaged in part-time academic work for that semester. This includes students registered for SUBJ 611.

Credit Loads for Internationals—The Immigration and Naturalization Service requires that international students proceed in a timely fashion toward completion of their degree, as established by the academic department and (usually) stated on their initial immigration document. Failure to maintain normal progress toward completion of the degree during this period will jeopardize the student's ability to continue academic study, adjust status or seek future employment in the United States. Because of this, students should not be enrolled less than full-time during fall or spring semester without approval by the Office of International Students and Scholars (ISS).

Employment—Many students depend upon part-time employment to help meet their expenses. A student who is thus employed, whether on or off campus, must recognize the time demands of a work schedule in planning an academic program. A student holding a fellowship or scholarship may not accept employment of any kind for service beyond that specifically permitted by the appointment. Graduate assistants may accept concurrent employment outside the University only after obtaining permission from the head of the department providing the assistantship and from the person in charge of the assistant's graduate program. A graduate assistant may not hold a concurrent appointment with the University other than a Fellowship Supplement.

For international students, guidelines for assistantships or employment are the same as for domestic students, with the following distinctions: (a) I-9 and W-4 forms must be processed through ISS; (b) vacation period employment may be up to forty hours per week; and (c) since Immigration and Naturalization Service regulations on employment are subject to change, all employment off campus for international students must be cleared through the Office of International Students and Scholars.

Full-Time Employment Off Campus—A candidate for the Ph.D. degree at a particular campus of the University may not count the work of any semester toward the residence requirement for this degree while engaged in full-time employment off campus or at a different campus of the University.

Staff Employee Credit Status—A full-time staff employee of the University may schedule up to 16 credits per academic year, either for credit or audit.

Full-time University employees may meet Ph.D. degree residence requirements by registering for 6 credits per semester or 4 credits per eight-week summer session and by obtaining certification from the department head as being principally engaged in activities directly relating to their degree objectives. A post-comprehensive full-time University employee may not register for SUBJ 601 (i.e., full-time thesis preparation), but may register for SUBJ 611 (part-time thesis preparation).

No member of the faculty in one of the professorial or professorial-equivalent ranks in the University may receive the master's degree or the doctoral degree from the University.

University staff employees who want to take graduate degree work must first be admitted to the Graduate School.

GRADING SYSTEM

A grade is given solely on the basis of the instructor's judgment as to the student's scholarly attainment. The following grading system applies to graduate students: A (EXCELLENT) indicates exceptional achievement; B (GOOD) indicates substantial achievement; C (SATISFACTORY) indicates acceptable but substandard achievement; D (POOR) indicates inadequate achievement and is a failing grade for a graduate student—a required course in which a D has been obtained cannot be used to meet degree requirements; and F (FAILURE) indicates work unworthy of any credit, and suggests that the student may not be capable of succeeding in graduate study. The grade-point equivalents for the above marks are: A, 4.00; B, 3.00; C, 2.00; D, 1.00; F, 0. A minimum grade-point average of 3.00 for work done at the University is required for all graduate degrees. In Fall 1995 a +/- grading system went into effect that includes A-, B+, B-, and C+. The grade-point equivalents are A-, 3.67; B+, 3.33; B-, 2.67; and C+, 2.33.

In addition to the quality grades listed above, two symbols, DF (deferred) and R, may appear on a student's transcript. If work is incomplete at the end of a semester because of extenuating circumstances, the instructor may report DF in place of a grade, which will appear temporarily on the student's record. It is not appropriate to use the DF either casually or routinely to extend a course beyond the end of the semester or to extend a course for a student who has failed so that the individual can do extra work to improve the grade. The DF must be removed (i.e., the course must be completed) within nine weeks of the beginning of the succeeding semester, with two possible exceptions: (a) a completion deadline longer than nine weeks may have been previously agreed upon by the instructor and student, with a memo on the agreement having been sent to the Office of Graduate Enrollment Services, 114 Kern, for inclusion in the student's file; or (b) as the nine-week deadline nears, it may become evident that an extension is warranted. The instructor then sends a request for an extension (to a specified date) to the Office of Graduate Enrollment Services, with a justifying statement.

It is to be emphasized that no deferred or missing grade may remain on the record at those times when a student reaches an academic benchmark. Benchmarks include completion of a master's program and the doctoral candidacy, comprehensive, and final oral examinations. Graduate programs may add additional benchmarks.

It is further noted that there are only three circumstances under which a course grade, once assigned, can be changed: (1) if there was a calculational or recording error on the instructor's part in the original

grade assignment (Senate Policy 48-30); (2) if it is a course for which an R grade has been approved and in which an initial R can be assigned and changed later to a quality grade; (3) if, as discussed above, a DF was assigned and the deadline for course completion has not yet passed. Deferred grade cards can be obtained from the University Registrar, 112 Shields.

Grade changes are governed by Senate Policy 48-30, found in *Policies and Rules*.

In the case of thesis work, either in progress or completed, and in certain courses (e.g., 590, 594, 595, 596, 597, 598, 599 and a few others) approved by the Graduate Council, the instructor may report the symbol R in place of a grade. An R does not influence the grade-point average. It indicates that the student has devoted adequate effort to the work scheduled but gives no indication of its quality. The symbol may be used, for instance, in courses that are officially designed to extend over more than one semester or in courses for which a quality grade is not appropriate. An R in an approved course need not be changed later to a quality grade, but may be changed if the instructor deems it appropriate when the course work has been completed. Normally, a quality grade must be reported no later than the end of the following semester.

When reported for thesis work, an R will not influence the grade-point average and remains on the student's transcript if not converted to a quality grade within one semester of its recording. *The Graduate Council has established upper limits of 6 credits of quality grades for master's thesis research and 12 credits for doctoral thesis research. The remaining credits must be assigned Rs.*

Pass-Fail (P/F) grading is used exclusively in certain graduate courses where it has been requested by the program and approved by the graduate dean following guidelines established by the Graduate Council. A grade of P does not influence the GPA, but an F does.

CONCURRENT CANDIDACIES

In general, graduate students are best advised to focus on one degree objective at a time. However, a candidate for an advanced degree in one major field who wishes to begin work for either a master's or a doctoral degree in a second field while concurrently completing the first program can petition to do so. The department heads of both fields and the dean of the Graduate School must approve any such plan. Approval will not be granted for concurrent double Ph.D. or D.Ed. degrees. Guidelines for preparation of a proposal for concurrent candidacies have been established by the Graduate Council and are available in the Office of Graduate Enrollment Services, 114 Kern.

DUAL TITLE DEGREE PROGRAMS

Students may apply for dual-title degrees in one of the dual-title programs approved by the Graduate Council. Students wishing to follow this course of action must already be enrolled in an existing graduate program and have a primary program in which the greater portion of the work will be conducted. The primary program will be supplemented by a secondary program in which substantial work is carried out under the supervision of a faculty adviser from the secondary program. Guidelines and information are available from the dean of the Graduate School.

INTEGRATED UNDERGRADUATE–GRADUATE STUDY

The Schreyer Honors College offers selected baccalaureate degree candidates the opportunity to integrate undergraduate and graduate courses of study in a continuous program culminating in both a baccalaureate and a master's degree.

A University Scholar who is granted Integrated Undergraduate–Graduate (IUG) status will have dual enrollment in an undergraduate program and in the Graduate School. Some credits earned as an undergraduate may be applied to both degree programs. Guidelines and information are available from The Schreyer Honors College.

Other Integrated Undergraduate–Graduate Programs—A limited number of approved Integrated Undergraduate–Graduate programs other than those in The Schreyer Honors College are also offered. These programs allow students to work on an undergraduate and a graduate degree at the same time and are intended for exceptional students who can perform their academic studies at an accelerated pace and take on the challenges of graduate courses and research while still enrolled as undergraduates. Typically, a certain number of credits may be applied to both degrees, and the total time for completing both degrees is less than if the degrees were earned separately. These programs include those within a single department, such as the BLA/MLA in Landscape Architecture, the BArch-MSArch program; and also those that are interdepartmental or intercollegiate programs, such as the integrated five-year science/business BS/MBA program. Guidelines and information are available from the dean of the Graduate School.

CHANGE OF DEGREE OR PROGRAM

A graduate student who has been admitted for work in one major program but who wants to transfer to another should submit a request to the Office of Graduate Enrollment Services of the Graduate School. The student's credentials will be reviewed and the proposed new major department head or committee chair consulted. If the change is approved but the student is inadequately prepared for the new major, the student may be required to make up certain deficiencies.

A graduate student admitted for either an academic degree (M.A., M.S., or Ph.D.) or a professional degree (M.Agr., M.B.A., M.C.P., M.E.P.C., M.Ed., M.Eng., M.F.A., M.F.R., M.H.A., M.H.R.I.M., M.L.A., M.M.E., M.M.M., M.Mus., M.P.A., or D.Ed.) who wants to change from one type of degree program to another must apply to the Office of Graduate Enrollment Services for the transfer. Similarly, a student who has earned a master's degree but who wants to earn a doctoral degree in a different field must apply for a formal transfer. A student may be required to make up certain deficiencies if inadequately prepared for the new program.

REGISTRATION NEAR THE COMPLETION OF A PROGRAM

A candidate for the Ph.D. degree is required to register continuously for each semester from the time the comprehensive examination is passed and the two-semester residence requirement is met until the thesis is accepted by the doctoral committee, regardless of whether work is being done on the thesis during this interval. (*See Registration and Continuous Registration.*)

Although there is no general continuous registration requirement for D.Ed. degree candidates and master's students, individual programs may require it. It should be noted, moreover, that (a) *proper registration* (*see Registration*) is expected of all graduate students; (b) graduate assistants must carry the prescribed credit loads (*see Credit Loads and Academic Status*); and (c) because of visa considerations, international students typically will register every semester, no matter what their degree objectives.

A master's candidate is not required to register for the final semester in order to graduate or in order to make minor revision to the thesis and/or to take a final examination for the degree, unless required to do so by the program.

THESIS

Thesis Research—To register for thesis research in all graduate major programs, a student uses the appropriate number (600 for on campus, 610 for off campus) preceded by the abbreviation designating the major field. The bursar assesses charges for these courses at the current rate of tuition according to the student's status at the time of registration.

Students registering for 600 or 610 should be aware that the Graduate Council has established limits on the total number of research credits that can be assigned letter grades in a student's program (i.e., other than R): 6 credits for master's candidates and 12 credits for doctoral candidates.

Thesis Preparation—The numbers 601 and 611 are available to Ph.D. degree candidates and are used for special noncredit registration for thesis preparation work. Such candidates must have passed the comprehensive examination and must have met the two-semester residence requirement. A candidate registered for SUBJ 601 is classified as a full-time student, while one registered for SUBJ 611 is classified as a part-time student.

The numbers 600, 601, 610, and 611 may not always appear in the *Schedule of Courses* for each semester, but they are available for registration each semester.

Thesis Deposit—When a student completes a thesis, an archival copy of the thesis must be submitted to the Graduate School (*see Thesis Acceptance*). A thesis accepted by the Graduate School is deposited after commencement in the University Libraries, where it is available for circulation.

GRADUATION

Students who plan to graduate at the end of the current semester/session are responsible for indicating an intent to graduate. To initiate an intent to graduate, students must call the telephone Registration/Graduation System at (814) 863-9000 (on campus dial 3-9000) during the designated time period for that semester. Any changes to a student's graduation status after this time period must be made by contacting Graduate Enrollment Services at (814) 865-1795.

Students who have been removed from the graduation list will need to initiate their intent to graduate again for the semester in which they plan to graduate.

A preliminary graduation list is prepared by the graduate recorder soon after the deadline for each semester or summer session. Transcripts are prepared and checked in the offices of the Graduate School and the recorder. Accepted theses, master's papers, and project reports are noted as may be relevant. The records of candidates who appear to have met requirements are forwarded to major and minor department heads or program chairs for review and recommendation. The final list of approved candidates appears in the fall, spring, or summer commencement program.

Only those transfer credits that have been accepted by the Graduate School and entered upon the student's transcript by the recorder before the graduate list deadline will be considered in evaluating a student for graduation at the end of that particular semester or summer session.

The University holds commencement exercises for graduate students three times a year: at the end of the fall and spring semesters and at the end of the summer session. Attendance at commencement exercises is expected, but forms for permission to receive the degree in absentia are available from the University Registrar, 112 Shields, or by accessing the Registrar's Web site at <http://www.psu.edu/registrar>.

All degrees conferred are tentative until final grade reports have been received and all requirements fulfilled, even though the student's name may have appeared in the commencement program. A student's transcript or diploma, or both, may be withheld until any outstanding financial obligations to the University have been paid.

UNSATISFACTORY SCHOLARSHIP

A graduate student who fails to maintain satisfactory scholarship or to make acceptable progress in a degree program will be dropped from the University. One or more failing grades or a cumulative grade-point average below 3.00 for any semester or session or combination of semesters and/or sessions may be considered as evidence of failure to maintain satisfactory scholarship. Action may be initiated by the department or committee in charge of the graduate major or by the chair of the student's doctoral committee. The procedures to be followed in such action are found in Appendix III in this *Bulletin*.

CONFIDENTIALITY OF STUDENTS' RECORDS

The Pennsylvania State University collects and retains data and information about students for designated periods of time for the express purpose of facilitating the students' educational development. The University recognizes the privacy rights of individuals in exerting control over what information about themselves may be disclosed and, at the same time, attempts to balance that right with the institution's need for information relevant to the fulfillment of its educational missions.

The University further recognizes its obligation to inform the students of their rights under the Family Educational Rights and Privacy Act of 1978 (FERPA), including: informing students of the existence and location of records as well as defining the purposes for which such information is obtained; providing security for such material; permitting students access to, disclosure of, and challenge to this information as herein described; and discontinuing keeping such information when compelling reasons for its retention no longer exist.

Student Record Policy—No information from records, files and data directly related to a student shall be disclosed by any means (including telephone) to individuals or agencies outside the University without the written consent of the student, except pursuant to lawful subpoena or court order, or in the case of specifically designated educational and governmental officials as required by FERPA. Information contained in such records may be shared within the University by University officials with "legitimate educational interest" in such information.

A more complete description of the University's policy on confidentiality of student records, including educational records and alumni records; disclosures to students, third parties, agencies and parents of dependent students; and challenges to entries, is contained in *Policies and Rules*, which is available at departmental and deans' offices.

GRADUATE DEGREE REQUIREMENTS

DOCTORAL DEGREES

The Doctor of Philosophy, an academic degree, and the Doctor of Education, a professional degree, are conferred by the University. Recognized as different in purpose, the two programs consequently have different requirements in certain respects.

ADMISSION

A student who has been admitted to the Graduate School and has been accepted by the department or committee in charge of a major program in which the doctorate is offered may begin working toward a doctoral degree. However, the student has no official status as a doctoral student and no assurance of acceptance as a doctoral candidate until the candidacy examination has been passed. This examination is administered by the major department or graduate program and is given early in the student's program.

It is the policy of the Graduate School not to encourage applicants to work for a second doctoral degree. (See Policy on Second Doctorates). However, the President, on recommendation of the dean of the Graduate School, will welcome, as guests, holders of earned doctoral degrees who may be visiting the University Park campus for purposes of noncredit study. Guest privileges apply to persons holding the degree from Penn State or other accredited colleges and universities. Guests may attend seminars and courses and, if space and facilities are available, carry on research. There will be no charge except for laboratory expenses. Arrangements should be made in advance with the dean of the Graduate School.

GENERAL REQUIREMENTS

No specified number of courses completed or credits earned will assure attainment of the doctorate. The general requirements are based upon a period of residence, the writing of a satisfactory thesis and its acceptance by the doctoral committee and the Graduate School, and the passing of a comprehensive and a final oral examination. A doctoral program consists of such a combination of course seminars and individual study and research as meets the minimum requirements of the Graduate School and is approved by the doctoral committee for each individual student.

A master's degree is not a prerequisite for the doctorate in some major programs. However, the first year of graduate study leading to the Ph.D. may be substantially the same as that provided for the M.A. or M.S. degree. Similarly, the first year of the D.Ed. program may be essentially the same as that provided for the M.Ed. degree.

GRADE-POINT AVERAGE

A minimum grade-point average of 3.00 for work done at the University is required for doctoral candidacy, for admission to the comprehensive examination, the final oral examination, and for graduation.

TIME LIMITATION

A doctoral student is required to complete the program, including acceptance of the doctoral thesis, within eight years from the date of successful completion of the candidacy examination. Individual programs may set shorter time limits. Extensions may be granted by the Director of Graduate Enrollment Services in appropriate circumstances.

OFF-CAMPUS AND TRANSFER CREDITS

Subject to the approval of the adviser and the head of the major department or program chair, a student may register for research to be done away from the University Park campus.

A maximum of 30 credits beyond the baccalaureate at an accredited school not granting the doctorate in the student's major program may be accepted by the Graduate School in partial fulfillment of the requirement for a D.Ed. degree at Penn State. A maximum of two full academic years of work (60 credits) beyond the baccalaureate at an accredited graduate school that grants the doctorate in the candidate's major program may be accepted here to apply toward D.Ed. degree requirements. A completed master's degree may be transferred to a D.Ed. program with no intervening time limitation. Because there is no total-credit requirement for the Ph.D. degree program, advanced standing is not awarded for a master's degree. Advanced standing is awarded for only one master's degree.

Academic work to be so transferred must meet the following criteria:

1. It must have been completed within five years prior to the date of first degree registration at the Graduate School of Penn State (see below);
2. It must appear on an official graduate transcript;
3. It must be of at least B quality;
4. It must be deemed applicable to the student's program by the current academic adviser, approved in writing, and submitted to the Graduate School for approval and action.

Credits earned toward a previously **completed** postbaccalaureate professional degree program (law, medicine, etc.) are not transferrable. However, up to 10 credits can be transferred from a professional degree program if the degree has not been conferred. All transfer credit must be substantiated by the former institution as having at least B quality whatever grading system is in place (e.g., this includes P/F grading).

ADVISERS AND DOCTORAL COMMITTEES

Following admittance to a degree program, the student should confer with the head of that major department or program concerning procedures and the appointment of an adviser. Consultation or arrangement of the details of the student's semester-by-semester schedule is the function of the adviser. This person may be a member of the doctoral committee or someone else designated by the head of the major program for this specific duty.

General guidance of a doctoral candidate is the responsibility of a doctoral committee consisting of four or more active members of the Graduate Faculty, which includes at least two faculty in the major field. This committee is appointed by the graduate dean through the Office of Graduate Enrollment Services, upon recommendation of the head of the major program, soon after the student is admitted to candidacy. A person not affiliated with Penn State who has particular expertise in the candidate's research area may be added as a special member, upon recommendation by the head of the program and approval of the graduate dean. A special member is expected to participate fully in the functions of the doctoral committee. If the outside expert is asked only to read and approve the doctoral thesis, that person is designated a *special signatory* of the thesis. Occasionally, special signatories may be drawn from within the Penn State faculty in particular situations.

At least one regular member of the doctoral committee must be from outside the candidate's major program. For candidates who are in one of the intercollege graduate degree programs, all members of the doctoral committee may be from the major program graduate faculty, but the committee membership must have representation from more than one department. If the candidate has a minor, that field must be represented on the committee. (See also Major Program and Minor Field under D.Ed.—Additional Specific Requirements in this *Bulletin*.) At the discretion of the dean, other members may be added to the committee. The supervisor of the candidate's thesis will usually, but not necessarily, be designated as chair. The chair, or at least one co-chair, of the doctoral committee must be a faculty member in the major field.

The doctoral committee is responsible for approving the broad outline of the student's program and should review the program as soon as possible after the student's admission to candidacy. Moreover, continuing communication among the student, the committee chair (or adviser) and the members of the committee is strongly recommended, to preclude misunderstandings and to develop a collegial relation between the candidate and the committee.

The (entire) committee will prepare, give, and evaluate the candidate's examinations. If a committee member is unable to attend the final oral defense, he or she will sign as a *special signatory*, after notifying Graduate Enrollment Services (114 Kern) that a committee change must be approved and made a part of the student's record. (Substitutes are not permitted, but changes in the committee can be made, if needed, through the usual procedures.) The department or program head will notify Graduate Enrollment Services when the candidate is ready to have the comprehensive and the final oral examinations scheduled and will report the results of these examinations to that office.

At least three members of the doctoral committee (including the thesis adviser or chair) must be physically present at the comprehensive or final oral examination. The graduate student must also be physically present at the exam. (Thus for a five-person committee, two could participate via distance.) No more than one member may participate via telephone; a second member could participate via PicTel. The examination request and a request for exceptions must be submitted to the dean of the Graduate School for approval at least three weeks prior to the date of the exam. Special arrangements, i.e., requirements for meeting participation via distance, should be communicated to the student and the doctoral committee members well in advance of the examination.

A favorable vote of at least two-thirds of the members of the committee is required for passing a comprehensive or a final oral examination. If a candidate fails an examination, it is the responsibility of the doctoral committee to determine whether another examination may be taken.

The committee examines the thesis, administers the final oral examination, and signs the signatory page of the thesis. At least two-thirds of the committee must approve the thesis.

ENGLISH COMPETENCE

A candidate for the degree of Doctor of Philosophy is required to demonstrate high-level competence in the use of the English language, including reading, writing, and speaking, as part of the language and communication requirements for the Ph.D. Programs are expected to establish mechanisms for assessing and improving competence of both domestic and international students. Assessments should include pieces of original writing. Programs and advisers should identify any deficiencies *before or at the candidacy examination* and direct students into appropriate remedial activities. Competence must be *formally* attested by the program before the doctoral comprehensive examination is scheduled. (International students should note that passage of the minimal TOEFL requirement does not demonstrate the level of competence expected of a Ph.D. from Penn State.)

COMMUNICATION AND FOREIGN LANGUAGE COMPETENCE

In addition to demonstrating competence in English as described above, each candidate for the Ph.D. must meet communication and foreign language requirements that have been established within the major program. The candidate should ascertain specific language requirements by contacting the professor in charge of the program, whose name appears with the program description under Graduate Programs, Faculty, and Courses.

Candidates for the Doctor of Education degree may be required to demonstrate competence in foreign languages.

CANDIDACY EXAMINATION

Every student who wishes to pursue a doctorate must take a candidacy examination administered by the Graduate Faculty in the graduate major program. It should be taken early in the student's program. The nature of the examination varies with the program and may be the master's examination if so prescribed by the program and understood by the student. The decision to admit or not to admit a student to candidacy must be made by the graduate faculty or a designated committee of graduate faculty in the program. For the Ph.D. student, the examination may be given after at least 18 credits have been earned in graduate courses beyond the baccalaureate. The examination must be taken within three semesters (summer sessions do not count) of entry into the doctoral program.

The student must be registered as a full-time or part-time degree student for the semester in which the candidacy examination is taken.

For the D.Ed. student, the examination should be given when the student has earned a total of about 30 credits, including the master's program and work done elsewhere. A student transferring from another graduate school with 30 or more transfer credits must take the candidacy examination prior to earning more than 25 credits here.

COMPREHENSIVE EXAMINATION

When a candidate for the Ph.D. or D.Ed. degree has substantially completed all course work, a comprehensive examination is given. (Note: Some programs require students to pass various "area" examinations, "cumulative" examinations, and the like, or require presentation of a thesis proposal, prior to the comprehensive. These are matters of departmental or program policy, distinct from the general policies of the Graduate School described here.)

A candidate for the Ph.D. must have satisfied the English competence and the communication and foreign language requirement before taking the comprehensive examination.

All candidates are required to have a minimum grade-point average of 3.00 for work done at the University at the time the comprehensive examination is given, and may not have deferred or missing grades.

The student must be registered as a full-time or part-time student for the semester in which the comprehensive examination is taken.

The examination is scheduled and announced officially by the graduate dean upon recommendation of the department or program head. Three weeks' notice is required by the Graduate School for scheduling this examination which may be open to the public at the department's discretion. It is given and evaluated by the entire doctoral committee and may be either written or oral, or both. A favorable vote of at least two-thirds of the members of the committee is required for passing. In case of failure, it is the responsibility of the doctoral committee to determine whether the candidate may take another examination. The results are reported to the Office of Graduate Enrollment Services.

At least three members of the doctoral committee (including the thesis adviser or chair) must be physically present at the comprehensive or final oral examination. The graduate student must also be physically present at the exam. (Thus for a five-person committee, two could participate via distance.) No more than one member may participate via telephone; a second member could participate via PicTel. The examination request and a request for exceptions must be submitted to the dean of the Graduate School for approval at least three weeks prior to the date of the exam. Special arrangements, i.e., requirements for meeting participation via distance, should be communicated to the student and the doctoral committee members well in advance of the examination.

When a period of more than six years has elapsed between the passing of the comprehensive examination and the completion of the program, the student is required to pass a second comprehensive examination before the final oral examination will be scheduled.

FINAL ORAL EXAMINATION

The doctoral candidate who has satisfied all other requirements for the degree will be scheduled by the graduate dean, on the recommendation of the department or program head, to take a final examination.

Three weeks' notice is required by the Office of Graduate Enrollment Services for scheduling this examination. Normally the final oral examination may not be scheduled until at least three months have elapsed after the comprehensive examination was passed, although the dean may grant a waiver in appropriate cases. The deadline for holding the examination is ten weeks before commencement. It is the responsibility of the doctoral candidate to provide a copy of the thesis to each member of the doctoral committee *at least one week* before the date of the scheduled examination.

Both the thesis adviser and the student are responsible for ensuring the completion of a draft of the thesis *and for adequate consultation with members of the thesis committee well in advance of the oral examination. Major revisions to the thesis should be completed before this examination.* The dissertation should be in its final draft, with appropriate notes, bibliography, tables, etc., at the time of the oral examination; both the content and style should be correct and polished by the time this final draft of the thesis is in the hands of the committee.

The final examination of the doctoral candidate is an oral examination administered and evaluated by the entire doctoral committee. It consists of an oral presentation of the thesis by the candidate and a period of questions and responses. These will relate in large part to the thesis, but may cover the candidate's whole program of study, since one of the purposes of the examination is to assess the general scholarly attainments of the candidate. The portion of the examination in which the thesis is presented is open to the public.

At least three members of the doctoral committee (including the thesis adviser or chair) must be physically present at the comprehensive or final oral examination. The graduate student must also be physically present at the exam. (Thus for a five-person committee, two could participate via distance.) No more than one member may participate via telephone; a second member could participate via PicTel. The examination request and a request for exceptions must be submitted to the dean of the Graduate School for approval at least three weeks prior to the date of the exam. Special arrangements, i.e., requirements for meeting participation via distance, should be communicated to the student and the doctoral committee members well in advance of the examination.

The student must be registered as a full-time or part-time degree student for the semester in which the final oral examination is taken.

A favorable vote of at least two-thirds of the members of the committee is required for passing. The results of the examination are reported to the Office of Graduate Enrollment Services. If a candidate fails, it is the responsibility of the doctoral committee to determine whether another examination may be taken.

THESIS ACCEPTANCE

Completion of the requirements of a doctoral degree program entails acceptance of the thesis, as indicated by the signatures of at least two-thirds of the doctoral committee, including the thesis adviser, committee chair, and the program chair or department head on its signatory page, and by its acceptance as meeting the editorial standards of the Graduate School, so that it constitutes a suitable archival document for inclusion in the University Libraries. Thus it is to be noted that passage of the final oral examination is necessary but not sufficient for award of the degree; the thesis must be accepted, as the ultimate step.

PH.D.—ADDITIONAL SPECIFIC REQUIREMENTS

The degree of Doctor of Philosophy is conferred in recognition of high attainment and productive scholarship in some special field of learning as evidenced by:

1. The satisfactory completion of a prescribed period of study and investigation;
2. The preparation and formal acceptance of a thesis involving independent research;
3. The successful passing of examinations covering both the special subject and the general field of learning of which this subject forms a part.

Residency Requirements—There is no required minimum of credits or semesters of study, but over some twelve-month period during the interval between admission to the Ph.D. program and completion of the Ph.D. program the candidate must spend at least **two semesters** as a registered full-time student engaged in academic work at the University Park campus, The Milton S. Hershey Medical Center, or Penn State Harrisburg. Full-time University employees must be certified by the department as devoting half-time or more to graduate studies and/or thesis research to meet the degree requirements. (*See Credit Loads and Academic Status.*)

Continuous Registration—It is expected that all graduate students will be properly registered at a credit level appropriate to their degree of activity. (*See Registration.*) After a Ph.D. candidate has passed the comprehensive examination and met the two-semester full-time residence requirement, the student must register continuously for each fall and spring semester (beginning with the first semester after both

of the above requirements have been met) until the Ph.D. thesis is accepted and approved by the doctoral committee. (Note that students who are in residence during summers must also register for summer sessions.)

Post-comprehensive Ph.D. students can maintain registration by registering for credits in the usual way, or by registering for noncredit 601 or 611, depending upon whether they are devoting full time or part time to thesis preparation. Students may take 601 plus up to 3 additional credits of course work for audit by paying only the dissertation fee. Students wishing to take up to 3 additional credits of course work for credit, i.e., 590, 602, etc., with 601 may do so by paying the dissertation fee and an additional flat fee. Enrolling for either 3 credits for audit or credit will be the maximum a student may take with SUBJ 601 without special approval by the Graduate School. Students wishing to take more than 3 additional credits of course work must register for 600 or 611 (i.e., not for 601, which is full-time thesis preparation). Note that the least expensive way for a student to work full-time on research and thesis preparation is to register for 601. This clearly is the procedure of choice for international students who need to maintain status as full-time students for visa purposes.

If a Ph.D. student will not be in residence for an extended period for compelling reasons, the graduate dean will consider a petition for a waiver of the continuous registration requirement. The petition must come from the doctoral committee chair and carry the endorsement of the department or program chair.

Minor Field—A Ph.D. candidate is not required by the Graduate Faculty to have a minor field of study. However, a department or a committee in charge of a major field may require a candidate to offer work in a minor field, or a student may elect such a program with the permission of the doctoral committee.

A minor consists of no fewer than 15 graduate credits of integrated or articulated work in one field related to, but different from, that of the major. A minor normally may be taken only in one of the approved graduate degree programs offered at Penn State, or in a formal graduate minor program that has been approved by the Graduate Council, such as the minors in comparative and international education; gerontology; high-performance computing; the humanities; literary theory, criticism, and aesthetics; linguistics; religious studies; science, technology, and society; or women's studies. The minor field chosen must have the approval of the departments or committees responsible for both the major program and the minor field. If more than one minor is being proposed, a separate group of courses must be taken for each (i.e., none of the courses may be used concurrently). If the student received a master's minor in the same field as is being proposed for a doctoral minor, the 15 credits taken must be above and beyond those used for the master's minor. However, credits earned in the master's program over and above those applied to either the master's minor or major may be applied to a minor in the Ph.D. program.

At least one faculty member from the minor field must be on the candidate's doctoral committee.

Thesis—The ability to do independent research and competence in scholarly exposition must be demonstrated by the preparation of a thesis on some topic related to the major subject. It should represent a significant contribution to knowledge, be presented in a scholarly manner, reveal an ability on the part of the candidate to do independent research of high quality, and indicate considerable experience in using a variety of research techniques. The contents and conclusions of the thesis must be defended at the time of the final oral examination.

When a complete draft of the thesis has been compiled, the student must submit it to the Thesis Office for format review. Submission for format review must be made by the announced deadline for the semester/session in which the degree will be conferred. After a successful defense and after signed approval by the advisers and/or committee members and the department head or graduate program chair, the final archival copy of the thesis (incorporating any format changes requested by the Thesis Office), must be deposited with the Thesis Office by the announced deadline for the semester/session in which the degree will be conferred. It is also expected that the student will provide a final archival copy of the thesis to the office of the department or program head.

A *Thesis Guide*, which gives details concerning format, paper, typing, and other requirements, can be accessed in several ways. A copy of the *Guide* can be obtained from the Thesis Office or accessed on the Web at http://www.gradsch.psu.edu/gs_overview/theses.html. In addition, several copies of the *Guide* are available in Pattee Library.

D.Ed.—ADDITIONAL SPECIFIC REQUIREMENTS

The D.Ed. degree is conferred in recognition of advanced preparation of a high order for work in the profession of education as evidenced by:

1. Satisfactory completion of a prescribed period of study;
2. Ability to apply scientific principles to practitioner problems in a variety of education endeavors;

3. Preparation of a thesis demonstrating ability to undertake an educational problem with originality and independent thought;
4. Successful performance on major and minor examinations, showing a satisfactory grasp of the field of specialization and its relation to allied education areas.

Residency Requirements—A minimum of six semesters of full-time graduate study and research (15 credits per semester), or their equivalent in credits (90 credits), of which at least 30 credits must be earned in residence at University Park campus, or Penn State Harrisburg if the degree is offered at that location, is required for the D.Ed. degree. The D.Ed. candidate may meet the requirements by attending summer sessions unless the major department requires a period of registration during the regular academic year. A candidate may register for a maximum of 30 credits of research in absentia, but none of these may count toward the minimum of 30 credits that must be earned at the University Park campus, or Penn State Harrisburg if the degree is offered at that location. It is expected that students will register for a minimum of 15 credits of thesis research.

Major Program and Minor Field—The program of study includes a major and either a minor or a group of general studies. A majority of the courses offered in fulfillment of the requirements must be in the major program of study.

A candidate choosing a major outside the fields of professional education (such as history) shall have a minor consisting of no fewer than 15 graduate credits in professional education, as recommended to the dean of the Graduate School early in the major program with the approval of a faculty adviser from the minor area.

A candidate choosing a major in one of the approved programs in professional education must also choose either a minor or a group of general studies with the approval of the major program chair. In this case, a minor consists of no fewer than 15 graduate credits in a field considered by the major program committee to provide valuable intellectual and/or professional depth and breadth for the candidate. There must be at least one faculty member from the minor field on the candidate's doctoral committee. The minor may include courses taken as part of a previous master's degree program, if the minor is in an area different from the master's, and if the courses were not a required part of the program, e.g., used to meet a total credit requirement.

An acceptable general studies group consists of at least 15 graduate credits, including those taken as part of a previous master's degree (up to 6 credits), considered by the major program committee to provide valuable intellectual breadth for the candidate. (Note that a general studies group is not a minor and is not entered as such on the student's transcript.)

A candidate entering with a master's degree in a field that would normally be regarded as appropriate for a minor may petition the major program committee for a waiver of the minor requirement. If the program chair then approves, a request for a waiver may be submitted by the chair to the dean of the Graduate School. Waiving the minor requirement does not reduce the residence or total credit requirements for the D.Ed. degree.

Comprehensive Examination—In addition to demonstrating a high level of competence in the subject matter in the major program and minor field, each candidate must show, by a comprehensive examination, an understanding of current theories of education and the ability to apply the techniques and findings of educational research so far as they bear upon the teaching of the subject matter. The candidate must also be able to understand and contribute to the technical and professional literature in the field, and to criticize learned procedures in the light of historical trends and practices in this and other countries. Command of the tools for a thorough study of the problems of education is necessary and must include competence in the use of statistical methods. For certain students the requirements may include a reading knowledge of one or more foreign languages.

All candidates are required to have a minimum grade-point average of 3.00 for academic work done at the University at the time the comprehensive examination is given.

Thesis—Evidence of a high degree of scholarship, competence in scholarly exposition, and ability to select, organize, and apply knowledge must be presented by the candidate in the form of a written thesis. The candidate must demonstrate a capacity for independent thought, as well as ability and originality in the application of educational principles or in the development of a new generalization under scientific controls. A thesis may be based upon a product or project of a professional nature, provided scholarly research is involved. For example, it may be based upon the solution of a professional problem concerned with the development of a curriculum, or a product of creative effort related to education. However, in order to be acceptable as a thesis, the professional project must be accompanied by a written discourse

demonstrating the nature of the research and including such theories, experiments, and other rational processes as were used in effecting the final result. The topic and outline of the proposed thesis must have the approval of the doctoral committee.

When a complete draft of the thesis has been compiled, the student must submit it to the Thesis Office for format review. Submission for format review must be made by the announced deadline for the semester/session in which the degree will be conferred. After a successful defense and after signed approval by the advisers and/or committee members and the department head or graduate program chair, the final archival copy of the thesis (incorporating any format changes requested by the Thesis Office), must be deposited with the Thesis Office by the announced deadline for the semester/session in which the degree will be conferred. It is also expected that the student will provide a final archival copy of the thesis to the office of the department or program head.

A *Thesis Guide*, which gives details concerning format, paper, typing, and other requirements, can be accessed in several ways. A copy of the *Guide* can be obtained from the Thesis Office or assessed on the Web at http://www.gradsch.psu.edu/gs_overview/theses.html. In addition, several copies of the *Guide* are available in Pattee Library.

MASTER'S DEGREES

The Graduate School recognizes a difference in purpose, which is reflected in the requirements, for two types of advanced degrees: academic and professional. Of the seventeen master's degrees conferred, the Master of Arts and Master of Science are academic in nature. The professional degrees conferred are Master of Agriculture, Master of Business Administration, Master of Community Psychology, Master of Education, Master of Engineering, Master of Environmental Pollution Control, Master of Fine Arts, Master of Forest Resources, Master of Health Administration, Master of Hotel, Restaurant, and Institutional Management, Master of Landscape Architecture, Master of Manufacturing Management, Master of Music, Master of Music Education, and Master of Public Administration.

A degree is not conferred for a mere collection of credits. A well-balanced, unified, and complete program of study is required, including in most instances the preparation and acceptance of a high-quality written document (thesis, paper, or project report). The overall program of the student frequently will exceed the minimum requirements as specified under M.A. and M.S.—Additional Specific Requirements (on the next page).

A student may meet the degree requirements by either full-time or part-time enrollment and by attendance in any combination of semesters and summer sessions. The student who interrupts the continuity of registration faces the possibility of not being granted permission to return.

ADMISSION

In addition to the general University requirements for admission set forth at the beginning of this *Bulletin*, adequate undergraduate preparation is required in the program in which the applicant expects to pursue advanced work. The specific courses and the total number of undergraduate credits required in various areas will be determined by the choice of program and can be ascertained from the descriptive statement appearing under the graduate program heading in the latter portion of this *Bulletin*. An applicant who meets the necessary grade-point average but is deficient in course preparation may, under certain circumstances, be admitted to the Graduate School and be allowed to make up the undergraduate deficiencies. Under these circumstances the program will require more than the usual required period of residence. An applicant for admission to the M.Ed. program in most major programs is required to have had at least 18 credits in education and related psychology, and in certain major programs may be required to have had practice teaching.

Requirements concerning courses, language proficiency, minors, comprehensive examinations, and other matters are sometimes made by departments or programs in addition to (but not in conflict with) the regulations of the Graduate School. For details, consult the head of the major department or program.

GRADE-POINT AVERAGE

A minimum grade-point average of 3.00 for work done at the University is required for graduation and to maintain good academic standing.

TIME LIMITATION

All requirements for a master's degree (including acceptance of a thesis, paper, or project report as may be specified), whether satisfied on the University Park campus or elsewhere, must be met within eight years of admission to degree status. Individual programs may set shorter time limits. Extensions may be granted by the director of Graduate Enrollment Services in appropriate circumstances.

TRANSFER CREDIT

Subject to the limitations given, a maximum of 10 credits of high-quality graduate work done at an accredited institution may be applied toward the requirements for the master's degree. However, credits earned to complete a previous master's degree may not be applied to a second master's degree program at Penn State.

The student should distinguish carefully between the transferability of credit and its applicability in a particular degree program. Approval to apply any transferred credits toward a degree program must be granted by the student's academic adviser and the Graduate School. Transferred academic work must have been completed within five years prior to the date of first degree registration at the Graduate School, must be of at least B quality (grades of B- are not transferrable), and must appear on an official graduate transcript. Credits earned toward a previously **completed** postbaccalaureate professional degree program (law, medicine, etc.) are not transferrable. However, up to 10 credits can be transferred from a professional degree program if the degree has not been conferred.

All transfer credit must be substantiated by the former institution as having at least B quality whatever grading system is in place. Pass-fail grades are not transferable to an advanced degree program unless the "Pass" can be substantiated by the former institution as having at least B quality.

Forms for transfer of credit can be obtained from the Office of Graduate Enrollment Services, 114 Kern, or the graduate program.

ADVISING

After admission to a degree program, a student should confer with the head of the major department or program concerning the appointment of an adviser. The general guidance of a master's candidate is the responsibility of an adviser, who is a member of the Graduate Faculty, or of a committee appointed in a manner to be determined by the major department or program in which the student is specializing. The adviser or the committee assists the student in planning a program of study. Although the adviser is frequently the supervisor of the thesis, this is not necessarily the case.

RESIDENCY REQUIREMENTS

Residency requirements have previously been met by a period of enrollment or the completion of a minimum number of credits that are administratively associated with a specific Penn State campus. In some cases this can allow students who never set foot on any Penn State campus to satisfy residency requirements by taking classes offered by distance means. In other cases, it can limit access to graduate education by imposing a burden on students who are location-bound or who can most effectively complete their graduate studies by combining courses offered at different Penn State locations.

For professional degree programs (M.Eng., M.Agr., M.Ed., etc.), it may not always be possible, desirable, or necessary to fulfill residency in the traditional manner. Availability of professional mentors and access to unique facilities at students' work sites or other locales may, in some instances, confer special advantages in well-designed off-campus degree programs. Professional degree programs that are not "off-campus degree programs" (i.e., those in which less than half of the course credits consist of off-campus courses) implicitly have a substantial involvement of the students with the campus responsible for the program, thus fulfilling the majority of the functions of residency. However, professional degree programs that are offered off-campus must incorporate as many of the essential elements of residency as possible, including faculty-student and student-student interaction, access instructional and other resources, exposure to and socialization in the field of study, and suitable academic advising.

Policies and guidelines pertaining to the offering of "off-campus" graduate degree programs are available through the dean of the Graduate School, 114 Kern.

EXAMINATIONS

A candidate may be required to pass in a satisfactory manner written or oral examinations designated by the program. A candidate should consult the major department or program for special requirements.

Examinations to establish credit for work done in absentia or without formal class work may be used to remove undergraduate deficiencies, but not to earn credits toward an advanced degree. Arrangements are made by the student directly with the major department head or program chair.

M.A. AND M.S.—ADDITIONAL SPECIFIC REQUIREMENTS

The Master of Arts and the Master of Science degrees have similar requirements, the general major area determining which degree is conferred. Programs for both degrees are strongly oriented toward research.

A minimum of 30 graduate credits is required, of which at least 20 must be earned at the established graduate campus/center of the University where the program is offered. Some graduate programs require

additional credits; the exact number can be determined by consulting the specific program description in the subsequent section, Graduate Programs, Faculty, and Courses. A minor is not required of all candidates for the M.A. or M.S. degree. A department or committee in charge of a major program may require a candidate to offer work in a minor field, or the minor may be elected with the permission of the student's committee.

Any member of the Penn State faculty with at least assistant professor rank may participate in the guidance and examination of master's candidates and sign master's thesis signatory pages. Special signatories occasionally are requested and approved for master's thesis. The supervisor of the master's work must be a member of the Graduate Faculty.

A minor consists of no fewer than 6 credits of integrated or articulated work in one field related to, but different from, that of the major. A minor program must be in one of the approved graduate degree programs offered at Penn State and must have the approval of the departments or committees responsible for both the major program and the minor field.

The major department or the committee in charge of the major program is the judge as to the suitability of a field for the minor and of its relevance to the major. The minor field department has the responsibility of accepting or rejecting students, advising on courses to be taken by the candidate in the field, examining the candidate in the area of studies undertaken in the field, and certifying that the minor requirements have been met.

At least 18 credits in the 500 and 600 series, combined, must be included in the program. A minimum of 12 credits in course work (400 and 500 series), as contrasted with research, must be completed in the major program. A thesis is required of many candidates for these degrees. Details are given in the introductory paragraphs under the major program headings in the latter part of this *Bulletin*. If a student is required to write a thesis, at least 6 credits in thesis research (600 or 610) must be included in the program. If no thesis is required, at least 18 credits must be in 500-level courses.

A thesis is prepared under the direction of the department or program in which the candidate's major work is taken. Under certain conditions a student may complete the thesis off campus. To do so, satisfactory arrangements must be made in advance with the adviser and the head of the major department or program.

When a complete draft of the thesis has been compiled, the student must submit it to the Thesis Office for format review. Submission for format review must be made by the announced deadline for the semester/session in which the degree will be conferred. After a successful defense and after signed approval by the advisers and/or committee members and the department head or graduate program chair, the final archival copy of the thesis (incorporating any format changes requested by the Thesis Office), must be deposited with the Thesis Office by the announced deadline for the semester/session in which the degree will be conferred. It is also expected that the student will provide a final archival copy of the thesis to the office of the department or program head.

A *Thesis Guide*, which gives details concerning format, paper, typing, and other requirements, can be accessed in several ways. A copy of the *Guide* can be obtained from the Thesis Office or accessed on the Web at http://www.gradsch.psu.edu/gs_overview/theses/html/. In addition, several copies of the *Guide* are available in Pattee Library.

Candidates who are not required to write a thesis must present a suitable essay or paper. Its nature and extent shall be determined by the major program. The department head or program chair shall report to Graduate Enrollment Services the title, the name of the faculty member under whom the student did the work, and that a draft of the work has been submitted by the published deadline for the semester. The department or program is responsible for ensuring that the work is finalized by the published deadline for the semester/session. The program head may require one or more copies of the essay for the program's library or other files.

Some programs in the field of education offer the M.S. degree but prefer to admit students into the M.Ed. degree program. Other programs that emphasize research prefer to admit only students interested in pursuing the Ph.D. degree.

Requirements for the M.A. degree at Penn State Harrisburg differ somewhat from the above and are outlined under the major programs in American Studies, Humanities, and Applied Psychology. These programs are available only at Penn State Harrisburg.

M.Agr.—ADDITIONAL SPECIFIC REQUIREMENTS

The Master of Agriculture is a professional degree. Programs leading to this degree provide opportunities for students to increase their knowledge and competencies in the various phases of agriculture. A student, according to individual objectives, may obtain intensive training encompassing a wide spectrum of subject matter area or intensive training in a specialized area. The program emphasizes the development of professional skills in the communication of technical knowledge and its application to the solution of current and future technical, economic, and social problems of individuals and groups.

The head of the department or program chair appoints a three-member committee to guide and monitor the candidate's professional development. Members of this committee must represent at least two departments. The chair of the appointed committee serves as the candidate's adviser. The candidate will inform the committee of personal aspirations and background early in the program. The committee will suggest to the student how best to achieve these goals and the standard of professional competence required for the Master of Agriculture degree.

A minimum of 30 graduate credits is required, of which 20 credits must be earned in residence at the University Park campus. A maximum of 10 credits may be earned in special problem-type courses.

Students in the Master of Agriculture degree program can major in Agricultural Economics, Agronomy, Animal Science, Entomology, Extension Education, Forest Resources, Horticulture, Plant Pathology, Rural Sociology, Soil Science, or Wildlife and Fisheries Science.

The candidate must present an acceptable paper on a selected professional problem or a report of internship training. Up to 3 graduate credits will be given for an acceptable paper. The candidate may be required to provide one or more copies of the paper for the University.

The candidate's committee shall report, through the department head or program chair, to the Office of Graduate Enrollment Services the title of the paper and that a draft of the work has been submitted by the published draft deadline for the semester. The department or program is responsible for ensuring that the work is finalized by the published deadline for the semester.

M.B.A.—ADDITIONAL SPECIFIC REQUIREMENTS

Master of Business Administration degree programs are offered at the University Park campus, Penn State Harrisburg, and Penn State Erie.

University Park Campus—The purpose of the M.B.A. degree program at the University Park campus is to develop professional managerial knowledge and skills as these are applied to decisions in complex organizations. The curriculum was developed by the graduate business faculty to blend technical rigor, managerial theory, and integrative learning experiences through case studies and other teaching methods.

A minimum of 48 graduate credits is required, with a minimum of 42 credits at the 500 level. Twenty-six credits must be in specific core courses. Also required are 22 credits in major field course and electives. Work for this degree may be started in the fall semester only. Applications for this AACSB-accredited M.B.A program must include the results of the Graduate Management Admission Test (GMAT).

Penn State Harrisburg—The students served by the M.B.A. program are, primarily, nontraditional and reside within the Capital Region. With the exception of a small percentage of students who are full-time, they are employees of area businesses, state and local governments, and not-for-profit organizations who study on a part-time basis.

The M.B.A. requires 48 credits of course work, including 18 credits of prerequisites and 30 credits in the program, for students entering the program with a nonbusiness baccalaureate. For those students who have a business degree, as many as 18 credits ("prerequisites") of the 48 credits may be waived based on an evaluation of the undergraduate record. Applicants must include results of the Graduate Management Admission Test. In addition to GMAT scores, applicants whose native language is not English must provide scores, and must achieve a minimum score of 550, on the Test of English as a Foreign Language (TOEFL).

Penn State Erie—The Penn State Erie M.B.A. is a general degree emphasizing development of the planning and problem-solving skills crucial in middle and upper management. Course work emphasizes the practical application of theory in the business world, to simulate problems or actual situations students are experiencing at work. The degree consists of 48 credits drawn from core and elective courses.

Core courses (36 credits) cover financial and managerial accounting; business communication; managerial economics; financial management; individual and group dynamics in organizations; organization design; management information systems; marketing; operations management; statistics; the legal, social, and political environment of business; and strategic planning and business policy.

The M.B.A. program's 12 elective credits allow students to develop in-depth knowledge in an area supportive of their career goals. Elective courses are offered in accounting, communications, economics, finance, human resource management, labor relations, international business, entrepreneurship, management of technology, management information systems, marketing, quantitative business analysis, and quality management. Opportunities to work one-on-one with Penn State Erie faculty also are available through independent study courses.

Admission is granted only to candidates who demonstrate high promise of success for graduate work. Nearly all students are fully employed professionals who bring a wealth of knowledge and experience to

the classroom. The program may be completed by attending classes offered on weeknights and/or Saturdays. A maximum of 10 credits may be transferred from another graduate institution. Either part-time or full-time study is possible. Applications must include the results of the Graduate Management Admissions Test.

Penn State Great Valley—The M.B.A. at the Penn State Great Valley School of Graduate Professional Studies is designed to meet the needs of the working professional desiring to advance her/his career. The 42-credit program assumes a minimum of three to five years of professional experience and is appropriate for those holding a degree in any academic discipline. The program consists of ten required courses and four electives. Those with little to no background in statistics, computer applications or accounting may be asked to take one or more refresher courses/modules prior to enrolling in the program.

Options are offered in Business Administration and Health Care Administration. Classes are offered in the evenings and on Saturdays. The program can be completed within three calendar years. Classes are admitted at the beginning of the fall and spring semesters. Applications must include the Graduate Management Admission Test.

M.C.P.—ADDITIONAL SPECIFIC REQUIREMENTS

The graduate program in Community Psychology at Penn State Harrisburg leads to a Master of Community Psychology degree, with concentrations in Individualized Studies, Counseling Skills, and Human Services Management. This is a nontraditional degree program that emphasizes experience in carrying out a master's project. The program is concerned with equipping students with some of the skills necessary to cope with the multifaceted problems facing communities. Students learn to recognize problems, to outline and implement possible solutions to these problems, and to evaluate the effectiveness of the solutions.

The program requires 36 credits, with 24 credits at the 500 level. Learning takes place both in courses and a master's project that entails field work and the writing of a master's paper.

M.Ed.—ADDITIONAL SPECIFIC REQUIREMENTS

The programs leading to the degree of Master of Education provide preparation for increased professional competence in education. They should be distinguished carefully from the research-oriented programs that lead to the academic degrees of Master of Arts or Master of Science. In most major programs the requirements for admission include 18 credits in education and related psychology.

A minimum of 30 graduate credits is required for the degree, of which at least 20 must be earned at the campus/center where the degree program is offered; at least 24 must be in course work. This degree is also offered in certain programs at Penn State Harrisburg and Penn State Great Valley.

Major Programs in the Fields of Education—A student can major in one of the approved programs in professional education (see Directory of Graduate Programs and Degrees Conferred, at the beginning of this *Bulletin*) and proceed under the guidance of a graduate faculty member of the appropriate major. At least 12 of the required credits in course work must be taken at the 500 level. Programs of this type generally require at least six credits to be earned outside the major in courses approved by the graduate faculty in the major as providing valuable breadth for the candidate. Specific information is found under the individual program listings in this *Bulletin* or from the program's coordinator. It is important for potential students to obtain degree requirements of the programs in which they are interested, since many programs specify degree requirements in excess of 30 credits.

Major Programs Outside the Fields of Education—A student who wants to earn an M.Ed. in a specific subject-matter field, such as economics, mathematics, German, or a broader area, can choose such a program as a major and take a majority of work in it under the guidance of the department offering that major. The candidate is required to earn 6 credits in education as directed by the faculty of one of the approved graduate programs in professional education.

Culminating Experience—All M.Ed. programs require a significant culminating or "capstone" experience. Each program has established the specific manner for meeting the requirement, which may take the form of a thesis, production, paper, exhibition, comprehensive examination or other similar experience serving to demonstrate comprehensive and in-depth knowledge of the field of study. The nature and extent of this work and when it is to be undertaken within the program of study shall be determined by the major program and reported to the Graduate School. The department or program is responsible for ensuring that the work is finalized by the published deadline for the semester and is reported to the Office of Graduate Enrollment Services.

Thesis or Paper—The thesis or paper must be of considerable proportion and must be clearly and definitively indicative of the capacity to describe a serious intellectual investigation, study, critical

analysis, or evaluation; to acquire, integrate, and analyze information; to draw conclusions logically; and to present the experience adequately and professionally in writing. The requirements of the Graduate School regarding a thesis must be met. Programs may impose other requirements regarding the master's paper, including submission of more than one copy for disposition at the program level.

Exhibition or Production—The capstone experience must be of comparable rigor as that required for a thesis or master's paper. While the format of the experience will differ among programs, all such capstone experiences must result in definitive evidence of satisfaction of the above noted qualities. Some tangible written report is required, although the length and nature of this report are to be left to the department or program.

Other Capstone Experience—If the program wishes to use some other mechanism to demonstrate culminating evidence of analytical ability and synthesis of material, it may do so upon approval by the Graduate Council. The program or department must provide to the Graduate School evidence that the student has met the approved requirement by the published deadline for the semester.

M.Eng.—ADDITIONAL SPECIFIC REQUIREMENTS

The programs leading to the Master of Engineering degree provide training for advanced professional competence in several fields of engineering. They should be distinguished carefully from the research-oriented programs that lead to the academic degree of Master of Science.

A minimum of 30 graduate credits is required, of which 20 must be earned at the campus/center where the degree program is offered. At least 12 credits must be earned in graduate courses (500 series).

A scholarly written report on a developmental study involving at least one area represented in the candidate's course work is required as an integral part of the program. The report must be comparable in its level of work and quality to a graduate thesis. The topic of the developmental study is subject to prior approval by the department in which the candidate's major work is taken, and preparation of the written report shall be under the direction of that department.

Work for this degree is not required to be done specifically at the University Park campus. A complete program of study can be pursued at Penn State Harrisburg or Penn State Great Valley.

M.E.P.C.—ADDITIONAL SPECIFIC REQUIREMENTS

The Master of Environmental Pollution Control (M.E.P.C.) is an intercollege professional degree program designed to improve competence in various fields of the control, management, and prevention of environmental pollution. The degree should be distinguished from the research-oriented program that leads to the academic degree of master of science, since the M.E.P.C. emphasizes application, analysis, and synthesis of knowledge rather than creating new information through traditional research.

A minimum of 30 graduate credits is required, of which 20 must be earned at the campus/center where the degree program is offered. Special requirements include 11–12 credits of core courses covering air pollution, water quality, solid/hazardous waste management, and policy/risk assessment. At least 15 credits must be earned in 500-level courses, which includes 1 credit of E P C 590 and up to 3 paper-writing (596) credits offered through the student's department of affiliation.

A scholarly master's paper must be completed by all M.E.P.C. candidates. It must be of considerable proportion and must demonstrate the ability to formulate objectives, acquire and document relevant information, critically analyze, draw logical conclusions, and relate findings to professional problems and practices.

M.F.A.—ADDITIONAL SPECIFIC REQUIREMENTS

The programs leading to the Master of Fine Arts degree provide professional training in art, creative writing, and theatre arts. The M.F.A. is one of three terminal degrees in the arts. (The others are the research-oriented Ph.D. and the teaching-oriented Ed.D.) The M.F.A. is a 48- to 60-credit degree and usually requires three years to complete.

The greater number of credits in the major should be at the 500 level, but the needs of the student will be considered in arranging the best combination of courses and research for preparing the candidate in a particular field.

A professional creative project is required. This project will include a monograph (an artist's statement for the M.F.A. in studio art) in support of the creative or interpretative aspect of the program. Continuance in the program is dependent upon the student's academic and artistic progress as evaluated at the end of each semester.

M.F.R.—ADDITIONAL SPECIFIC REQUIREMENTS

The Master of Forest Resources (M.F.R.) is a professional degree designed for students who want to specialize in fields of wood products marketing or industries, forest management, silviculture, urban forestry, watershed management, or wildlife and fisheries management. This degree differs from the research-oriented Master of Science degree programs in the School of Forest Resources, because the M.F.R. emphasizes applications, analysis, and synthesis of knowledge rather than creating new information through more traditional types of research. Of particular concern are problems involving human, biological, and technological interactions. This program is especially attractive to returning students interested in gaining state-of-the-art information rather than thesis research in their specialized field.

Students who have baccalaureate degrees in forestry, wood products, or wildlife and fisheries may complete the M.F.R. degree requirements in one year, whereas those with degrees in related fields generally require a longer time period because of deficiencies in prerequisite undergraduate courses.

A minimum of 30 graduate credits (400- to 500-level courses) is required, of which at least 20 must be earned at the campus/center where the degree program is offered. At least 12 credits must be formal courses at the 500 level related to forest resources and wildlife and fisheries, excluding 596 credits. A paper (6 to 9 credits of FOR/W P/W F S 596) will be part of the 30 credits, which demonstrates an ability to apply the knowledge gained during the program to the specialized field of interest. Additional requirements include 2 credits of colloquium and 3 credits of statistics.

M.H.A.—ADDITIONAL SPECIFIC REQUIREMENTS

The professional Master of Health Administration (M.H.A.) program is offered concurrently with the Master of Business Administration (M.B.A.) program. The M.H.A. program helps prepare students for managerial positions in hospitals, nursing homes, managed care organizations, as well as health insurance and pharmaceutical companies, etc. The M.H.A. curriculum includes health administration, the nature of health and illness, the structure of health service systems, and health policy.

Scores from the Graduate Management Admission Test (GMAT) are required for admission into the M.H.A./M.B.A. concurrent degree program. The M.H.A. degree requirements include three preprogram requirements and a minimum of 37 credits of graduate courses taken concurrently with M.B.A. credits for a total of 63 credits for the M.H.A. and M.B.A. concurrent degrees. Before entering, students must have demonstrated proficiency equivalent to the material in an undergraduate course in microeconomics, introductory financial accounting, and introductory statistics. These courses will not be counted toward the M.H.A. degree. The program office can provide information on different vehicles for meeting these preprogram requirements.

M.H.A. degree is designed to be completed in twenty-one months of full-time study and must be taken concurrently with the M.B.A. degree offered by The Smeal College of Business Administration. By agreement of the Graduate School, a portion of the graduate credits may count for both the M.H.A. and M.B.A. programs, thus making it possible to complete the proposed program in the suggested time period. Much of the core management content is taken within the M.B.A. program in conjunction with that program's required courses. The 37 credits of required and elective courses in the M.H.A. program focus on content in health care organization, policy, finance, administration, information systems, law, and epidemiology. Included, also, within these required credits are a four-week summer intersession course and an eleven-week integrative internship during the summer following the first year of study in the M.H.A. and M.B.A. programs and an integrative capstone seminar experience occurring during the fourth academic semester.

Penn State Harrisburg—Based on eight core courses defined as the foundation of administration in health care, the degree program is designed for part-time professional students already engaged in health administration careers. Three years of relevant experience is an admission requirement. If the applicant's GPA is less than 3.0, GRE or GMAT scores are required.

M.H.R.I.M.—ADDITIONAL SPECIFIC REQUIREMENTS

The Master of Hotel, Restaurant, and Institutional Management program is a 36-credit professional degree program designed for individuals who have at least two years of managerial experience and a desire to improve their knowledge bases to become better prepared for executive positions in the hospitality industry. The program blends an emphasis on the functional and conceptual aspects of hospitality management with a cutting-edge focus on their application to the hospitality industry. The development and enhancement of individual leadership, team building, and problem-solving skills is an integral part of

this program. Within the 36 credits required for the degree, there is a 3-credit professional project and 9 elective credits within which students focus their programs of study.

Appropriate preparation includes managerial competency in accounting, statistics, economics, and computer technology. Students with deficiencies in these areas may be admitted provisionally.

M.L.A.—ADDITIONAL SPECIFIC REQUIREMENTS

The Master of Landscape Architecture program is structured as advanced scholarly inquiry within the professional discipline. The program requires a student to have a professional design degree from an accredited undergraduate program (or foreign equivalent) in landscape architecture or in architecture. The goal of the program is for each student to develop, through guided independent work, strength in a self-selected area of specialty within landscape architecture. Students work primarily in a mentorship relationship with one or more members of the graduate faculty. The faculty represent expertise in design theory and criticism, landscape architectural history, and landscape ecology. It is expected that students will choose to concentrate their own work in one of these three areas of expertise, and that the primary adviser will be selected based upon similar professional interests.

A minimum of 44 credits is required, and at least 34 credits must be earned at the University Park campus. Nineteen credits of graduate-level studio are required, and the larger portion of the course work should be at the 500 level. Beyond these criteria, the goals of the individual student and discussions between the student and the primary adviser determine the best combination of specific courses and research topics.

Each student will also complete a professional project or a formal thesis as the capstone experience of the program.

M.M.M.—ADDITIONAL SPECIFIC REQUIREMENTS

The Master of Manufacturing Management (M.M.M.) is a professional degree conferred jointly by the College of Engineering and The Smeal College of Business Administration, both national leaders in education and research. The M.M.M. degree is administered by the Quality and Manufacturing Management (QMM) program, an integrated one-year academic program with an enrollment limit of forty-five students, combining individuals with backgrounds in business, engineering, science, and industry.

While a student may enter the QMM program immediately after completing a baccalaureate degree in engineering, business, or science, an internship with a manufacturing company in the summer before entering the program is required for students with no industrial experience. Students take ten required core courses. Upon starting the academic year in the fall, students with an engineering or science background are required to take an introductory core course in business principles, while those with a business background must take an introductory core course in engineering design principles. The introductory business or engineering course as well as the nine remaining core courses are all 3-credit courses to be completed over a two-semester period. All core courses have been specifically designed for this program, and most integrate engineering and business concepts in the classroom.

All applicants from industry must submit scores from the Graduate Record Examination (GRE) or the Graduate Management Admission Test (GMAT). In addition, they must have a minimum of one year of relevant industry work experience and a baccalaureate degree in physical science, engineering, business, or management from an accredited university.

Applicants who are currently enrolled as undergraduates may apply for admission to the program in their senior year. They should have a minimum cumulative grade-point average of 3.0 at the time of application, and must complete an appropriate three-month internship before admission. Additionally, applicants from institutions other than Penn State must submit either GRE or GMAT scores. All students whose native language is not English must achieve a minimum score of 600 on the Test of English as a Foreign Language (TOEFL). The TOEFL requirement is waived for international students who have successfully completed undergraduate or graduate work in a U.S. or Canadian college or university.

All students entering the program must be competent in mathematics, statistics, and computer programming.

M.Mus.—ADDITIONAL SPECIFIC REQUIREMENTS

The program leading to the Master of Music degree provides training for increased professional competence in performance, pedagogy, conducting, composition. It should be distinguished carefully from the research-oriented program that leads to the academic degree of Master of Arts.

A minimum of 36 credits is required, of which 30 must be earned at the University Park campus. At least one-half of the required credits must be at the 500 level.

Depending on the major option, a professional project in performance, conducting, or composition is required. Also required are a master's paper and a comprehensive examination.

M.M.E.—ADDITIONAL SPECIFIC REQUIREMENTS

The Master of Music Education degree provides opportunity for advanced study in the art of music, pedagogy, and systematic problem solving. In addition to the traditional academic year program, a "summer only" option is available.

A minimum of 30 credits is required, of which 20 must be earned at the University Park campus. At least one-half of the required credits must be at least 500 level.

Admission requires 12 to 15 credits in music education methods at the undergraduate level, successful teaching or student teaching experience, and a videotaped demonstration of teaching and musical competence. Also required are a master's paper and a comprehensive examination.

M.P.A.—ADDITIONAL SPECIFIC REQUIREMENTS

The Master of Public Administration is a professional degree for students who are planning careers in public administration in local, state, and national governmental jurisdictions or in international, private, or voluntary agencies. The M.P.A. degree is offered at Penn State Harrisburg.

The M.P.A. degree at Penn State Harrisburg requires a minimum of 45 graduate credits including a 9-credit field study (internship) experience and a professional master's project. The 9-credit field study requirement may be waived for students who have at least three years of full-time professional experience in relevant administrative or staff work. There is no comprehensive final examination.

The program leading to the Master of Public Administration degree should be distinguished from the research-oriented program that leads to the academic degree of Master of Arts with a major in political science, in which the candidate may specialize in public administration.

PENNSYLVANIA DEPARTMENT OF EDUCATION CERTIFICATE CANDIDATES

Postbaccalaureate candidates for all Level I Instructional, Supervisory, Educational Specialist, and Administrative certificates issued by the Pennsylvania Department of Education upon the recommendation of the University must be admitted to Penn State as degree or certificate graduate students. Graduate students who want to pursue a Level I certificate in conjunction with an advanced degree must contact the Office of Certification and Education Services (228 Chambers, [814] 865-0488) in addition to submitting an application to the Graduate School. The credentials for certification-only students will be forwarded by the Office of Certification and Education Services to the Graduate School.

All Level I certification candidates are advised that a Precertification Competency Examination must be completed prior to issuance of a certificate. This examination samples the knowledge base needed by teachers and other educators in order to educate the handicapped in the least restrictive environment. The examination is individually administered usually during the semester preceding the candidate's internship or major practicum. Information on preparing for the examination is available from graduate faculty advisers or the Office of Certification and Education Services in 228 Chambers. There is no charge for this examination.

The Pennsylvania Department of Education (PDE) requires that all certification candidates hold United States citizenship. Further, candidates must be known by the preparing institution as persons of good moral character, not in the habit of using narcotic drugs in any form or excessive amounts of intoxicating beverages (School Code 1209), and not under indictment or convicted of a criminal offense (Act 33 and 34). Also, applicants for the first Pennsylvania Instructional I certificate must present to PSU and PDE passing scores on the appropriate PRAXIS Series/NTE prior to issuance of the certificate by PDE. Passing scores are those in effect at the time the candidates are recommended for certification. Information on these PDE requirements is available in 228 Chambers; (814) 865-0488.

Professional Development Certificates—Postbaccalaureate candidates who want to pursue course work simply for their professional development and/or a permanent Level II certificate should apply to the Graduate School as special nondegree graduate students.

GRADUATE PROGRAMS, FACULTY, AND COURSES

A course abbreviation, a number, and a title designate each course. Course designations and official abbreviations are listed above the first course in each group. The figures in parentheses following the course title show the number of credits that may be granted for that course. In the case of courses with variable credits, the number of credits that may be earned in a single semester is determined by the department or program offering the course.

A department or major program may schedule an entire section of a course below the 400 level for fewer credits than the maximum authorized. In 400-level courses, a student may schedule fewer credits than the maximum number but in no case more than the maximum number authorized. No 600-level courses (supervised college teaching; on- and off-campus research; and full- and part-time dissertation work) are listed with individual programs. All courses listed under graduate majors may not be required in the particular major.

COMMON COURSES

The following courses for which students may register have been set up for common use by major programs to encourage innovation and provide flexibility in designing graduate programs. For courses 594, 595, 596, 597, 598, and 599, special titles may be requested by a graduate program for a given semester, through the Senate Curriculum Recorder, Birch Cottage.

590. COLLOQUIUM—Continuing seminars that consist of a series of individual lectures by faculty, students, or outside speakers.

594. RESEARCH TOPICS—Supervised student activities on research projects identified on an individual or small-group basis. A specific title may be used in each instance and will be entered on the student's transcript. Multiple offerings may be accommodated by the use of suffixes A, B, etc.

595. INTERNSHIP—Supervised off-campus, nongroup instruction, including field experiences, practicums, or internships. Written and oral critique of activity required. A specific title may be used in each instance and will be entered on the student's transcript. Multiple offerings may be accommodated by the use of suffixes A, B, etc. Prerequisite: prior approval of proposed assignment by instructor.

596. INDIVIDUAL STUDIES—Creative projects, including nonthesis research, that are supervised on an individual basis and which fall outside the scope of formal courses. A specific title may be used in each instance and will be entered on the student's transcript. Multiple offerings may be accommodated by the use of suffixes A, B, etc.

597, 598. SPECIAL TOPICS—Formal courses given on a topical or special interest subject which may be offered infrequently; several different topics may be taught in one year or semester. A specific title may be used in each instance and will be entered on the student's transcript. Multiple offerings may be accommodated by the use of suffixes A, B, etc.

599. FOREIGN STUDIES (1–2 per semester, maximum of 4) Courses offered in foreign countries by individual or group instruction. A specific title may be used in each instance and will be entered on the student's transcript. Multiple offerings may be accommodated by the use of suffixes A, B, etc.

600, 610. THESIS RESEARCH—In registering for thesis research a student uses the appropriate number (600, 610) preceded by the abbreviation designating the major field. The numbers 600 (on campus) and 610 (off campus) are available for credit in thesis research in all graduate major programs. The bursar assesses charges for these courses at the current rate of tuition, according to the student's status at the time of registration.

601, 611. THESIS PREPARATION—The numbers 601 and 611, with associated special fees, are available to Ph.D. degree candidates who have passed the comprehensive examination and met the two-semester residence requirement. They may be used for thesis preparation work during its later stages, when the academic activity of the candidate consists partly (611) or solely (601) of work on the completion of research and writing of the dissertation. (*See also* Course-Numbering System.)

SUBJ 601 and SUBJ 611 do not carry academic credit. They are entered on the academic transcript to indicate the registration and the nature of the candidate's academic activity. A candidate registered for

SUBJ 601 is classified as a full-time student, while one registered for SUBJ 611 is classified as a part-time student. (See also Thesis Preparation, in the GENERAL INFORMATION section of this bulletin.)

The numbers 600, 601, 610, and 611 may not appear in the *Schedule of Classes* for each semester.

602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING—May be offered by any graduate program in a department that also offers undergraduate courses. A graduate program with no counterpart undergraduate program may offer SUBJ 602 when cooperative arrangements are made with an administrative unit that does not offer graduate degrees but that uses graduate assistants in its teaching. SUBJ 602 may be offered in any semester and is subject to the following restrictions:

1. SUBJ 602 will not be counted in fulfilling any specific credit requirement for an advanced degree.
2. SUBJ 602 will be graded (A, B, C, D, F). The grade will appear on the student's transcript.
3. SUBJ 602 will not be used in calculating grade-point averages.
4. SUBJ 602 shall be offered only in those graduate programs that want to provide opportunity for supervised and graded teaching experience. Enrollment will be restricted to students for whom the major program is prepared to provide such experience.
5. SUBJ 602 will be counted as a part of the student's credit load unless the program specifies otherwise.

ACOUSTICS (ACS)

ANTHONY ATCHLEY, *Head of the Graduate Program in Acoustics*
217A ARL Building
814-865-6364; Fax—814-865-3119

Degrees Conferred: Ph.D., M.S., M.Eng.

The Graduate Faculty

Carter L. Ackerman, Ph.D. (Penn State) *Associate Professor of Engineering Research*
Anthony A. Atchley, Ph.D. (U of Mississippi) *Professor of Acoustics, Program Head*
Ingrid M. Blood, Ph.D. (Bowling Green) *Associate Professor of Communication Disorders*
David L. Bradley, Ph.D. (Penn State) *Professor of Acoustics*
Russell C. Burkhardt, Ph.D. (Penn State) *Assistant Professor of Acoustics*
Courtney B. Burroughs, Ph.D. (Catholic) *Research Associate; Assistant Professor of Acoustics*
R. Lee Culver, Ph.D. (California, San Diego) *Research Associate; Assistant Professor of Acoustics*
Stephen P. Dear, Ph.D. (Penn) *Assistant Professor of Acoustics*
John E. Dzielski, Ph.D. (MIT) *Research Associate, Assistant Professor of Acoustics*
Thomas A. Frank, Ph.D. (Wisconsin) *Professor of Communication Disorders*
Thomas B. Gabrielson, Ph.D. (Penn State) *Associate Professor of Acoustics*
Steven L. Garrett, Ph.D. (UCLA) *United Technologies Professor of Acoustics*
Kenneth E. Gilbert, Ph.D. (Michigan State) *Associate Professor of Acoustics*
Ralph R. Goodman, Ph.D. (Michigan) *Senior Scientist, Professor of Acoustics*
Grant A. Gordon, Ph.D. (Penn State) *Assistant Professor of Acoustics*
Stephen A. Hambric, D.Sc. (George Washington) *Assistant Professor of Acoustics*
Sabih I. Hayek, D.Eng.Sc. (Columbia) *Professor of Engineering Mechanics*
L. Raymond Hettche, Ph.D. (Carnegie Mellon) *Professor of Engineering Research*
W. Jack Hughes, Ph.D. (Penn State) *Senior Research Associate; Associate Professor of Acoustics*
Claus P. Janota, Ph.D. (Penn State) *Research Associate; Assistant Professor of Acoustics*
Robert M. Keolian, Ph.D. (U of California) *Associate Professor of Acoustics*
Gary H. Koopmann, Ph.D. (Catholic) *Professor of Mechanical Engineering*
John S. Lamancusa, Ph.D. (Wisconsin, Madison) *Associate Professor of Mechanical Engineering*
Gerald C. Lauchle, Ph.D. (Penn State) *Professor of Acoustics*
Julian D. Maynard, Ph.D. (Princeton) *Professor of Physics*
Diana F. McCammon, Ph.D. (Penn State) *Senior Research Associate; Associate Professor of Acoustics*
Timothy E. McDevitt, Ph.D. (Penn State) *Research Associate*
Dennis K. McLaughlin, Ph.D. (MIT) *Professor of Aerospace Engineering*
Francis R. Menotti, Ph.D. (Connecticut) *Research Associate*
Philip J. Morris, Ph.D. (Southampton) *Professor of Aerospace Engineering*
Karl M. Reichard, Ph.D. (Virginia Polytech) *Assistant Professor of Acoustics*

Dennis W. Ricker, Ph.D. (Purdue) *Senior Research Associate; Associate Professor of Acoustics*
 K. Kirk Shung, Ph.D. (Washington) *Professor of Bioengineering*
 Leon H. Sibul, Ph.D. (Penn State) *Senior Scientist; Professor of Acoustics*
 Victor W. Sparrow, Ph.D. (Illinois, Urbana-Champaign) *Associate Professor of Acoustics*
 Richard Stern, Ph.D. (UCLA) *Professor of Applied Science and Mechanics*
 David C. Swanson, Ph.D. (Penn State) *Research Associate; Assistant Professor of Acoustics*
 William Thompson, Jr., Ph.D. (Penn State) *Professor of Engineering Science*
 Dennis W. Thomson, Ph.D. (Wisconsin) *Professor of Meteorology*
 Jiri Tichy, D.Sc. (Prague Inst. of Tech.) *United Technologies Professor of Acoustics*
 Bernhard R. Tittmann, Ph.D. (UCLA) *Kunkle Professor of Engineering Science and Mechanics*
 Martin W. Trethewey, Ph.D. (Michigan Tech.) *Professor of Mechanical Engineering*
 Lora G. Weiss, Ph.D. (Penn State) *Associate Professor of Acoustics*

The aim of this program is to enable the student interested in acoustics to obtain an integrated program covering acoustical science and engineering applications of acoustics.

Student curricula are individually tailored and integrated through a selection of core and elective courses in areas such as basic acoustics, physical acoustics, underwater acoustics, signal processing, optics, architectural acoustics, medical ultrasonics, aeroacoustics, vibrations, wave propagation, speech, physiological acoustics, psychoacoustics, thermoacoustics, hydroacoustics, and computational acoustics. The courses are offered by the Graduate Program in Acoustics and by other participating University departments, including Aerospace Engineering, Architectural Engineering, Bioengineering, Electrical Engineering, Engineering Science and Mechanics, Mechanical Engineering, Meteorology, Geosciences, Physics, Speech Communication, and Communication Disorders.

Admission Requirements

Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Entering students should hold a bachelor's degree in physics, engineering, mathematics, or in a closely related field that would provide substantial preparation in mathematics (calculus through differential equations, complex variables, linear algebra), engineering physics and other fundamental areas of relevance to graduate studies in acoustics. Students with a 3.00 junior/senior average (on a 4.00 scale) and with appropriate course backgrounds will be considered for admission. The best qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds and abilities.

Scores from the Graduate Record Examination (GRE) are required.

Other Relevant Information

In addition to the acoustics courses listed here, the following courses on acoustics and closely related areas are available: AERSP 511, 524, 525; A E 458, 520; BIOE 506, 516; CMDIS 430, 515, 531, 532, 533, 534, 535, 572, 573; CMPEN 485; E E 459, 530, 557, 560, 561, 562; E SC 536, 537; E MCH 412, 516, 521, 522, 524A,B,C, 525, 527, 528, 560, 562, 570, 597B; GEOSC 507A,B; METEO 435, 527, 536, 551; M E 458, 597; PHYS 443, 533.

Student Aid

Graduate assistantships and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

ACOUSTICS (ACS)

- 401. GENERAL ACOUSTICS (3)
- 402. INTRODUCTION TO ACOUSTICS (3)
- 403. MODERN ELECTRONICS FOR ENGINEERING ACOUSTIC APPLICATIONS (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

501. FUNDAMENTALS OF ACOUSTICS I (2) Vibrational concepts of acoustics: natural frequency and modes, resonances of lumped parameter systems, strings, elastic rods, beams, and membranes. Prerequisites: PHYS 202, 203; engineering mathematics, including differential equations.

502. FUNDAMENTALS OF ACOUSTICS II (2) Acoustical wave phenomena: propagation, transmission, reflection, and energy; periodic and transient waves; plane, spherical, and standing waves. Prerequisites: PHYS 202, 203; engineering mathematics including differential equations.

505. EXPERIMENTAL TECHNIQUES IN ACOUSTICS (2) Properties of acoustical and vibrational transducers, electronic and other instrumentation used in fundamental data measurement, acquisition, and analysis. Prerequisites: ACS 501, 502.
506. EXPERIMENTAL TECHNIQUES IN OCEAN ACOUSTICS (2) Development of measurement techniques and experimental procedures for making acoustic measurements in the ocean. Prerequisites: ACS 501, 502, 505.
510. FUNDAMENTALS OF ACOUSTICS (3) In-depth presentation of the fundamental principles of acoustics; designed to prepare students to take advanced courses in acoustics. (For telecommunications students only.)
511. UNDERWATER SOUND PROPAGATION (3) Theoretical and empirical treatment of sound propagation in the ocean, including effects of the environment, characteristics of targets, and transducers.
512. SONAR ENGINEERING (3) Theoretical and empirical treatment of problems related to the use of underwater sound in target detection and ranging.
513. DIGITAL SIGNAL PROCESSING (3) Discrete linear systems, transforms, digital filter design and applications, discrete Fourier transforms, spectrum analysis.
514. ELECTROACOUSTIC TRANSDUCERS (3) The theory, design, and calibration of passive, linear, reciprocal electroacoustic transducers for use in both air and water media. Prerequisite: ACS 501, 502.
515. ACOUSTICS IN FLUID MEDIA (3) Wave propagation in stationary and moving fluids; acoustic radiation and scattering; standing waves in ducts and cavities. Prerequisites: E MCH 524A; ACS 501, 502.
516. ACOUSTICAL DATA MEASUREMENT AND ANALYSIS (3) Presents the engineering applications of recent developments in correlation and spectral analysis to acoustical measurement problems.
517. TECHNIQUES FOR SOLVING ACOUSTIC FIELD PROBLEMS (3) Transient and time-harmonic acoustic radiation and scattering problems involving various boundary conditions, solved by exact, approximate, and numerical methods. Prerequisites: ACS 515, E MCH 524B.
518. ADAPTIVE SIGNAL PROCESSING (3) Basic concepts and application of adaptive signal processing techniques; adaptive filters beamformers; optimum space/time processors and their adaptive implementation; adaptive algorithms. Prerequisite: E E 459 or equivalent.
519. SOUND-STRUCTURE INTERACTION (3) Acoustic radiation from and effects of fluid-loading on vibrating infinite and finite plates and shells. Acoustic transmission through and reflection from elastic plates and shells, acoustic excitation of elastic plates and coupling between panels and acoustic spaces. Prerequisites: ACS 501, 502, E MCH 524B; or E MCH 525.
521. (E MCH) STRESS WAVES IN SOLIDS (3) Recent advances in Ultrasonic Nondestructive Evaluation: waves, reflection and refraction; horizontal shear; multilayer structures; stress; viscoelastic media; testing principles. Prerequisites: E MCH 524A, 524B.
590. COLLOQUIUM (1)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)
- FLOW-INDUCED NOISE (3)
 - INTENSITY TECHNIQUE (1)
 - COMPUTATIONAL ACOUSTICS (3)
 - (M E) NONLINEAR ACOUSTICS (3)
 - ACTIVE CONTROL OF SOUND AND VIBRATION (3)
 - (M E) ADVANCED NOISE CONTROL (3)
 - SONAR SIGNAL PROCESSING (3)
 - (M E) PERTURBATION METHODS IN ACOUSTICS AND MECHANICAL ENGINEERING (3)
 - OCEAN ACOUSTICS (3)
 - ACTIVE ECHO LOCATION AND SONAR (1)
 - THERMOACOUSTICS (3)
 - PHYSICAL ACOUSTICS (3)
 - SHALLOW WATER ACOUSTICS (2)
 - NOISE CONTROL ENGINEERING (2)
 - MUSIC ACOUSTICS (3)
 - ARCHITECTURAL ACOUSTICS (2)
 - TRANSDUCER LAB (2) Acoustic Imaging: Theory and Application (3)
598. SPECIAL TOPICS (1-9)

ADULT EDUCATION (ADTED)

EUNICE N. ASKOV, *In Charge of Graduate Programs in Adult Education*
314 Keller Building
814-863-3781

Degrees Conferred: D.Ed., M.Ed.

The Graduate Faculty

Eunice N. Askov, Ph.D. (Wisconsin) *Professor of Education*
Ian Baptiste, Ed.D. (Northern Illinois) *Assistant Professor of Education*
JoAnne Burley, Ph.D. (Pittsburgh) *Affiliate Assistant Professor of Education*
Barbara Copland, D.Ed. (Penn State) *Affiliate Assistant Professor of Education*
Andrea D. Ellinger, Ph.D. (Georgia) *Assistant Professor of Education*
Daniele Flannery, Ph.D. (Wisconsin) *Assistant Professor of Education*
Gary W. Kuhne, D.Ed. (Penn State) *Assistant Professor of Education*
Dennis Lott, D.Ed. (Penn State) *Affiliate Assistant Professor of Education*
Gary E. Miller, D.Ed. (Penn State) *Affiliate Associate Professor of Education*
Michael G. Moore, Ph.D. (Wisconsin) *Associate Professor of Education*
Donna S. Queeney, Ph.D. (Penn State) *Affiliate Associate Professor of Education*
Fred M. Schied, Ed.D. (Northern Illinois) *Associate Professor of Adult Education*
Joan S. Thomson, Ph.D. (Wisconsin) *Associate Professor of Rural Sociology Extension; Affiliate Associate Professor of Education*
Kimberly A. Townsend, D.Ed. (Penn State) *Affiliate Assistant Professor of Education*
Armando Villarroel, Ph.D. (Michigan) *Affiliate Assistant Professor of Education*

The focus of a program leading to a degree in Adult Education is the facilitation of purposeful continuing learning by men and women—alone, in groups, in the community, or in institutional settings. Adult Education extends through the life span from late adolescence to advanced age and takes place in a rich diversity of organizational as well as informal settings. The purpose of the Adult Education program is to increase the knowledge and competence of those who work with adult learners. Course work, reading assignments, projects, internships, informal discussions, and the dissertation all provide opportunities for in-depth, mind-stretching, and challenging learning experiences. The programs are interdisciplinary, and students are advised to seek learning beyond the minor in supporting fields within the University.

The Adult Education program is designed for each student, taking into consideration differences in life experience, including education, work, family situation, and plans for future employment. Typically, people interested in Adult Education are engaged in or oriented toward careers as researchers, administrators, counselors, instructors, and program planners in learning environments such as community development, staff development, professional continuing education, corrections education, literacy and adult basic education, religious education, human services, correspondence/distance learning, higher education, and university extension.

Scheduling is arranged, so far as possible, to accommodate the employed student, although full-time study is recommended. Entering students are expected to have a concept of their major interest and possible thesis subject, which may be developed during course work.

Admission Requirements

Scores from the Graduate Record Examination (GRE), or from the Miller Analogies Test (MAT), are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in the program without these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Applicants with a total Verbal and Quantitative score above 1100 on the GRE, a junior/senior average of 3.00 (on a 4.00 scale), and a graduate average of 3.50 are usually admitted to the D.Ed. program. Applicants with a junior/senior average of 2.70, a graduate average of 3.20, and a GRE total score of 1000 but with special backgrounds, abilities, and interests also may be admitted to the doctoral program with only the baccalaureate degree, but they will earn the master's degree en route. The Miller Analogies Test may be accepted in place of the GRE for admission to the graduate program in Adult Education. A sample of student writing and a "career letter" in which applicants explain how the proposed studies in adult education relate to their careers are required for each degree.

Master's Degree Requirements

M.Ed. students are required to write a master's paper in lieu of a thesis, in addition to the required 33 credits of course work. A minimum of 12 credits in course work must be taken at the 500 level. At least 18 credits must be in Adult Education courses.

Doctoral Degree Requirements

D.Ed. students who do not have previous experience in adult education are expected to acquire the equivalent of one year of experience in one or more fields of adult education practice prior to receiving their D.Ed. degree. During the comprehensive examination, in addition to being examined in their area of specialization, all D.Ed. students will be examined in the core adult education areas. A minimum of 24 credits in course work must be taken in Adult Education.

Student Aid

Graduate assistantships and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

ADULT EDUCATION (ADTED)

460. INTRODUCTION TO ADULT EDUCATION (3)

470. (CI ED) INTRODUCTION TO DISTANCE EDUCATION (3)

496. INDEPENDENT STUDIES (1-18)

497, 498. SPECIAL TOPICS (1-9)

505. THE TEACHING OF ADULTS (3) Examination of direct and indirect teaching; contracts, application of current technology, andragogy, motivation, evaluation; knowledge of research. Prerequisite: ADTED 460.

506. PROGRAM PLANNING IN ADULT EDUCATION (3) Intensive study of theoretical foundations, policies, evaluation models, methods, and materials in program planning in adult education. Prerequisites: ADTED 460, 505.

507. RESEARCH AND EVALUATION IN ADULT EDUCATION (3) Guided discussion and reading in selected research and evaluation methods and trends as applied in adult education settings. Prerequisites: ADTED 460; introductory statistics course; introductory research design course.

510. HISTORICAL AND SOCIAL ISSUES IN ADULT EDUCATION (3) Social and historical foundations of adult education in the United States and selected nations. Prerequisite: ADTED 460.

531. COURSE DESIGN AND DEVELOPMENT IN DISTANCE EDUCATION (3) In-depth study of the practices of designing courses taught by print, broadcast, and telecommunications media to adult distance learners. Prerequisites: ADTED 470, INSYS 415.

532. RESEARCH AND EVALUATION IN DISTANCE EDUCATION (3) Study of previous, current, and needed research, strategies, and issues concerning evaluation in distance education. Prerequisites: ADTED 460, 470.

540. SERVING ADULT LEARNERS IN HIGHER EDUCATION (3) Seminar on the characteristics and needs of adult students in the higher education context: motivations, persistence, faculty development, advising/counseling. Prerequisite: ADTED 460 or consent of instructor.

541. (WMNST) WOMEN AND MINORITIES IN ADULT EDUCATION (3) Seminar on women and minority adults as learners and leaders in the various contexts of adult education. Prerequisite: ADTED 460.

542. PERSPECTIVES ON ADULT LEARNING THEORY (3) Introduction to adult education learning theory, principles, and models of adult learning by adults alone, in groups, and in communities.

549. (HI ED) COMMUNITY JUNIOR COLLEGE AND THE TECHNICAL INSTITUTE (2-3) Distinctive contributions to meeting the need for postsecondary education; development, functions, curriculum and instruction, government, administration, and finance.

550. QUALITATIVE RESEARCH IN ADULT EDUCATION (3) Introduction to the theory, principles, and practice of qualitative research.

560. (LL ED) TEACHING READING TO COLLEGE STUDENTS AND ADULTS (3) Reading/literacy for adults, including college reading, Adult Basic Education (ABE), and General Educational Development (GED) programs. Prerequisite: LL ED 440 or teaching experience.

570. (CI ED) COMPARATIVE AND INTERNATIONAL ADULT EDUCATION (3) Critical and comparative analysis of adult education theory and practice outside North America, including international agency involvement. Prerequisite: ADTED 460.

575. (EDADM) ADMINISTRATION OF ADULT EDUCATION (3) Organization of a program of adult education; legal status, finances, selection of teachers, learning personnel, housing; other administrative problems. Prerequisite: ADTED 506 or EDADM 480.
580. ADULT EDUCATION RESEARCH SEMINAR (1-3) A seminar dealing with specific research topics and methods in adult education. Open to advanced students in adult education. Prerequisites: ADTED 507, EDPSY 400, 475.
588. PROFESSIONAL SEMINAR: RESEARCH AND ADULT EDUCATION (3) Review of research in adult education, current and past, with analysis of its directions, effects, methodology, quality, financing, and prospects. Prerequisites: ADTED 460, 507.
590. COLLOQUIUM (1-3)
594. RESEARCH TOPICS (1-18)
595. INTERNSHIP IN ADULT EDUCATION (3-9) Supervised student internship in adult education agency. Prerequisite: ADTED 460.
596. INDIVIDUAL STUDIES (1-9)
- 597, 598. SPECIAL TOPICS (1-9)

AEROSPACE ENGINEERING (AERSP)

DENNIS K. McLAUGHLIN, *Head of the Department*
233 Hammond Building
814-865-2569

Degrees Conferred: Ph.D., M.S., M.Eng.

The Graduate Faculty

Anthony K. Amos, Ph.D. (Princeton) *Professor of Aerospace Engineering*
Michael L. Billet, Ph.D. (Penn State) *Senior Scientist*
Cengiz Camci, Ph.D. (Von Karman Inst.) *Associate Professor of Aerospace Engineering*
George S. Dulikravich, Ph.D. (Cornell) *Associate Professor of Aerospace Engineering*
Farhan S. Gandhi, Ph.D. (Maryland) *Assistant Professor of Aerospace Engineering*
J. William Holl, Ph.D. (Penn State) *Professor Emeritus of Aerospace Engineering*
Budugur Lakshminarayana, Ph.D., D.Eng. (Liverpool) *Evan Pugh Professor of Aerospace Engineering*
George A. Lesieur, Ph.D. (California) *Associate Professor of Aerospace Engineering*
Lyle N. Long, Ph.D. (George Washington) *Professor of Aerospace Engineering*
Mark D. Maughmer, Ph.D. (Illinois) *Associate Professor of Aerospace Engineering*
Barnes W. McCormick, Jr., Ph.D. (Penn State) *P.E. Professor Emeritus of Aerospace Engineering*
Dennis K. McLaughlin, Ph.D. (MIT) *Professor of Aerospace Engineering*
Robert G. Melton, Ph.D. (Virginia) *Associate Professor of Aerospace Engineering*
Michael M. Micci, Ph.D. (Princeton) *Professor of Aerospace Engineering*
Philip J. Morris, Ph.D. (Southampton) *Boeing/A. D. Welliver Professor of Aerospace Engineering*
Blaine R. Parkin, Ph.D. (Cal. Tech.) *P.E. Professor Emeritus of Aerospace Engineering*
Edward C. Smith, Ph.D. (Maryland) *Associate Professor of Aerospace Engineering*
Hubert C. Smith, Ph.D. (Virginia) *Associate Professor of Aerospace Engineering*

Opportunities for graduate study are available in the following areas: low-speed aerodynamics, V/STOL aircraft, turbulence, astrodynamics, turbomachinery, aeroacoustics, gas dynamics, hydrodynamics, stability and control of aerospace vehicles, aerospace structures, computational fluid dynamics, experimental fluid dynamics, space propulsion, and space vehicle dynamics.

Admission Requirements

Applicants must submit official scores from the Graduate Record Examination (GRE) for admission to the graduate program and consideration for financial assistance. In addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin, the department poses a number of specific requirements. The entering M.Eng. or M.S. student must hold a bachelor's degree in engineering, physical science, or mathematics, and may be required to complete (without degree credit) undergraduate course work in fluid and solid mechanics and intermediate mathematical analysis, if not already completed. The department will consider students with a 3.0 junior/senior grade-point average (on a 4.0 scale) and with the appropriate course backgrounds for admission to the M.Eng. or M.S. program; students with special backgrounds, abilities, and interests may request a waiver to the minimum

3.0 grade-point average. The best-qualified applicants will be accepted up to the number of spaces that are now available to new students. Admission to the Ph.D. program requires satisfactory completion of a master's program in engineering, physical science, or mathematics.

M.Eng., M.S., and Ph.D. Core Requirements

1. Two courses for 6 credits in basic field theories, one in each of two different categories from a prescribed list in fluid mechanics, solid mechanics, or system dynamics.
2. One 3-credit course from a prescribed list in numerical or computational methods for analysis of differential equations.
3. One 3-credit course from a prescribed list of 500-level applied mathematics courses.
4. M.S. and Ph.D. candidates must demonstrate evidence of experimental experience.
5. Teaching assistants and teaching aides must satisfactorily complete ENGR 588.
6. M.S. and Ph.D. candidates must present their theses at a public seminar at Penn State.
7. (M.Eng. only) a 2-credit scholarly paper.
8. (M.Eng. only) a 1-credit graduate colloquium.

Master of Engineering Degree Requirements

A total of 30 credits is required, including courses in the core requirements. Twenty-one credits must be in aerospace engineering courses with at least 18 credits at the 500 level. A student may take a maximum of 6 credits of 400-level course work. Each student must complete a scholarly paper (completed for 2 credits of AERSP 596), including a review of the literature and some experiment or analysis, and take the 1-credit graduate colloquium.

Master of Science Degree Requirements

A total of 30 credits is required, including courses in the core requirements. Twelve credits must be in aerospace engineering courses with at least 6 credits at the 500 level. A student may take a maximum of 6 credits of 400-level course work. Six credits of thesis research are also required. Completion of an M.S. thesis is required for graduation.

Doctoral Degree Requirements

There is no foreign language requirement for the Ph.D. degree; however, students must demonstrate proficiency in reading, writing, and speaking English through an English proficiency examination administered by the department. This satisfies the Graduate School's requirement that must be completed before taking the comprehensive exam. The candidate's doctoral committee decides which, if any, courses are required in addition to those specified in the core requirements.

During the progression on the Ph.D. program, the doctoral committee administers the following examinations: The candidacy examination is given as a preliminary aptitude test before the end of the second semester. A comprehensive examination covering the major and minor fields of study is administered after the candidate has substantially completed the required course work. The final oral examination, which is related mainly to the thesis, is given after the candidate has satisfied all other degree requirements. All Ph.D. students must maintain continuous registration until the thesis is approved.

Student Aid

Graduate assistantships and other forms of financial aid are described in the STUDENT AID section of the *Graduate Bulletin*.

AEROSPACE ENGINEERING (AERSP)

- 401A. SPACECRAFT DESIGN—PRELIMINARY (2)
- 401B. SPACECRAFT DESIGN—DETAILED (2)
- 402A. AIRCRAFT DESIGN—PRELIMINARY (2)
- 402B. AIRCRAFT DESIGN—DETAILED (2)
- 403. DESIGN OF AIR TRANSPORT SYSTEMS (3)
- 404H. FLIGHT VEHICLE DESIGN AND FABRICATION II (3)
- 405W. AERODYNAMICS LABORATORY (2)
- 406W. STRUCTURES AND DYNAMICS LABORATORY (2)
- 407. AERODYNAMICS OF V/STOL AIRCRAFT (3)
- 410. AEROSPACE PROPULSION (3)
- 411. AEROELASTICITY (3)
- 412. TURBULENT FLOW (3)

413. STABILITY AND CONTROL OF AIRCRAFT (3)
420. PRINCIPLES OF FLIGHT TESTING (3)
423. INTRODUCTION TO NUMERICAL METHODS IN FLUID DYNAMICS (3)
424. INTRODUCTION TO NUMERICAL METHODS ON PARALLEL COMPUTERS (3)
425. THEORY OF FLIGHT (3)
430. SPACE PROPULSION AND POWER SYSTEMS (3)
450. ORBIT AND ATTITUDE CONTROL OF SPACECRAFT (3)
473. (E MCH) COMPOSITES PROCESSING (3)
490. (E E, NUC E) INTRODUCTION TO PLASMAS (3)
492. (ASTRO, E E) SPACE ASTRONOMY AND INTRODUCTION TO SPACE SCIENCE (3)
494. AEROSPACE UNDERGRADUATE THESIS (1–3 per semester, maximum of 6)
496. INDEPENDENT STUDIES (1–18)
497. SPECIAL TOPICS (1–9)
504. AERODYNAMICS OF V/STOL AIRCRAFT (3) Jet wings, high lift devices, propellers and ducted propellers, circulation and boundary layer control, unsteady airfoil theory. Prerequisite: AERSP 407.
505. AERO- AND HYDROELASTICITY (3) Interaction of elastic systems having several degrees of freedom with fluid flows in various configurations.
506. ROTORCRAFT DYNAMICS (3) Modeling and analysis techniques for dynamic response, vibration, aeroelastic stability, and aeromechanical stability of rotary-wing vehicles.
507. THEORY AND DESIGN OF TURBOMACHINERY (3) Theory and principles of machinery design: compressors, turbines, pumps, and rotating propulsors; opportunity to work out design examples.
508. FOUNDATIONS OF FLUID MECHANICS (3) Mathematical review, fluid properties, kinematics, conservation laws, constitutive relations, similarity principles, the boundary layer, inviscid flow, vorticity dynamics, wave motion.
509. DYNAMICS OF IDEAL FLUIDS (3) Irrotational flow theory, two-dimensional and axisymmetric flows, airfoil theory, complex variables, unsteady phenomena; flow with vorticity, finite wing theory. Prerequisite: AERSP 508.
510. COMPRESSIBLE FLOW (3) Classification and solution of compressible flow problems, high-speed gas dynamics, unsteady motion, transonic and hypersonic flows, atmospheric reentry.
511. AERODYNAMICALLY INDUCED NOISE (3) Review of fluid mechanics. General theory of aerodynamic sound. Noise radiation from jets, boundary layers, rotors, and fans. Structural response.
512. VISCOUS FLOW (3) Stress-deformation relations; Newtonian fluids, Navier-Stokes equations; exact, asymptotic laminar solutions; instability, transition; similitude and turbulent boundary layer.
514. STABILITY OF LAMINAR FLOWS (3) The stability of laminar motions in various geometries as influenced by boundary conditions and body forces of various kinds.
518. DYNAMICS AND CONTROL OF AEROSPACE VEHICLES (3) Dynamical problems of aircraft and missiles, including launch, trajectory, optimization, orbiting reentry, stability and control, and automatic control. Prerequisite: AERSP 413 or 450.
524. (M E) HOMOGENEOUS TURBULENCE (3) First in two-part series. Similarity and scaling, vorticity dynamics; Fourier spectral representation; interscale energy transfer. Numerical simulations and experimental measurement. Prerequisite: A graduate-level course in fluid mechanics.
525. (M E) INHOMOGENEOUS TURBULENCE (3) Second in two-part series. Instability and transition; turbulence models; Reynolds stress closure schemes; large eddy simulations; wave models; turbulence measurements. Prerequisite: AERSP 524.
526. (M E) COMPUTATIONAL METHODS FOR SHEAR LAYERS (3) Study of numerical solution methods for steady and unsteady laminar or turbulent boundary-layer equations in two and three dimensions. Prerequisite: AERSP 423 or M E 540.
527. (M E) COMPUTATIONAL METHODS IN TRANSONIC FLOW (3) Numerical solution of partial differential equations of mixed type, with emphasis on transonic flows and separating boundary layers. Prerequisite: AERSP 423 or M E 540.
528. (M E) COMPUTATIONAL METHODS FOR RECIRCULATING FLOWS (3) Numerical solution techniques for laminar/turbulent flow with large recirculation zones. Both primitive variable and stream function-vorticity equations used. Prerequisites: AERSP 423, M E 540.
529. ADVANCED ANALYSIS AND COMPUTATION OF TURBOMACHINERY FLOWS (3) Review of numerical methods; three-dimensional inviscid flow computation, two- and three-dimensional viscous flow effects and computation; recent advances. Prerequisites: AERSP 423; AERSP 507 or M E 418.
530. AEROTHERMOCHEMISTRY OF ADVANCED PROPULSION SYSTEMS (3) Physics and chemistry needed to analyze advanced rocket propulsion systems including reacting high temperature radiating gas and plasma flows. Prerequisite: AERSP 312 or M E 434.

540. (E E, NUC E) **THEORY OF PLASMA WAVES** (3) Solutions of the Boltzmann equation; waves in bounded and unbounded plasmas; radiation and scattering from plasmas. Prerequisite: AERSP (E E, NUC E) 490.
550. **ASTRODYNAMICS** (3) Applications of classical celestial mechanics to space flight planning. Determination and construction of orbital parameters by approximation methods. Perturbation techniques. Prerequisite: AERSP 450 or ASTRO 460 or E MCH 410 or PHYS 419.
590. **COLLOQUIUM** (1-3)
596. **INDIVIDUAL STUDIES** (1-9)
597. **SPECIAL TOPICS** (1-9)

AGRICULTURAL AND BIOLOGICAL ENGINEERING (A B E)

ROY YOUNG, *Head of the Department of Agricultural and Biological Engineering*
250 Agricultural Engineering Building
814-865-7792

Degrees Conferred: Ph.D., M.S.

The Graduate Faculty

Dennis R. Buckmaster, Ph.D. (Michigan State) P.E. *Associate Professor of Agricultural Engineering*
Dennis E. Buffington, Ph.D. (Minnesota), P.E. *Professor of Agricultural Engineering*
Herschel A. Elliott, Ph.D. (Delaware) P.E. *Professor of Agricultural Engineering*
Robert E. Graves, Ph.D. (Massachusetts) P.E. *Professor of Agricultural Engineering*
James M. Hamlett, Ph.D. (Iowa State) P.E. *Associate Professor of Agricultural Engineering*
Paul H. Heinemann, Ph.D. (Florida) *Associate Professor of Agricultural Engineering*
James W. Hilton, Ph.D. (Iowa State) *Associate Professor of Agricultural Engineering*
Joseph Irudayaraj, Ph.D. (Purdue) *Assistant Professor of Agricultural Engineering*
Albert R. Jarrett, Ph.D. (Penn State) P.E. *Professor of Agricultural Engineering*
Harvey B. Manbeck, Ph.D. (Oklahoma State) P.E. *Distinguished Professor of Agricultural Engineering*
Dennis J. Murphy, Ph.D. (Penn State) C.S.P. *Professor of Agricultural Engineering*
Virendra M. Puri, Ph.D. (Delaware) *Professor of Agricultural Engineering*
Paul D. Robillard, Ph.D. (Cornell) *Associate Professor of Agricultural Engineering*
Alan C. Rotz, Ph.D. (Penn State) *Adjunct Professor of Agricultural Engineering*
Robert D. Shannon, Ph.D. (Indiana) *Assistant Professor of Agricultural Engineering*
David G. Wagner, Ph.D. (Colorado State) P.E. *Assistant Professor of Agricultural Engineering*
Paul N. Walker, Ph.D. (Massachusetts) P.E. *Professor of Agricultural Engineering*
Eileen F. Wheeler, Ph.D. (Cornell) *Assistant Professor of Agricultural Engineering*
Roy Young, Ph.D. (N Carolina State) P.E. *Professor of Agricultural Engineering*
Kenneth M. Lomax, Ph.D. (Maryland) *Adjunct Associate Professor of Agricultural Engineering*

Graduate programs are available in the areas of the physical properties of biological materials, plant and animal production systems, food engineering, wood engineering, agricultural structures, agricultural safety, food safety, bulk solids handling and storage systems, agricultural systems engineering, agricultural by-product utilization, forage processing and handling systems, horticultural engineering, electronics instrumentation, on-line computer control systems, microclimate modification, erosion and sedimentation control, waste management, water quality, and natural resources management and conservation.

Excellent facilities, including equipment and instrumentation, are available for research in the designated areas. Among the special facilities are a GIS modeling lab; field plot areas; a full-scale sedimentation basin test facility; hydraulic flumes; sedigraph; gas an ion chromatography units; atomic absorption unit; rainfall simulators; food properties lab; computer vision systems; hydraulic and pneumatic test stands; fabrication shop; electronics instrumentation; microcomputer laboratory; controlled environment chambers; wood structures lab; and wood mechanics lab. Collaborative arrangements allow access to a large variety of other resources: Environmental Resources Research Institute; Particulate Materials Center; Housing Research Center; Center for Food Manufacturing; USDA Pasture Systems and Watershed Management Research Lab; a mushroom research and demonstration facility and a 1,500-acre agricultural research center for cooperative work with agronomic and horticultural production systems as well as animal production systems.

Admission Requirements

All students must submit scores from the General Aptitude Test of the Graduate Record Examination (GRE) prior to admission except those who have an ABET-accredited engineering degree. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

An undergraduate major in engineering is normally a prerequisite to work in the major. Students without an undergraduate engineering degree will be considered for admission on a provisional basis pending the completion of a number of additional credits to be specified on an individual basis. These remedial courses must be completed with a minimum grade-point average of 2.75.

The best-qualified applicants will be accepted up to the number of spaces that are available for new students.

Master's Degree Requirements

All candidates for the M.S. degree must prepare a thesis. In addition, 24 credits of course work are required. Each program should include at least one course each from the areas of agricultural and biological engineering, agricultural/biological science, and mathematics or statistics and A B E 500 Research Methods. Additional program details are contained in a syllabus available from the department. A total of at least 12 credits of course work must be at the 500 level.

Doctoral Degree Requirements

The communication requirement for the Ph.D. degree may be satisfied by either 6 credits of courses in an approved sequence or a foreign language.

All students should complete a master's program before seeking the doctoral degree.

A graduate student who wants to become a doctoral candidate must be approved for candidacy by the candidacy examination committee of the agricultural and biological engineering department. No specified number of courses completed or credits earned are required by the department, except that the candidate must take at least 9 credits of course work, including 6 at the 500 level, in agricultural and biological engineering beyond the baccalaureate degree and a seminar beyond the master's degree. A doctoral committee appointed by the Graduate School will approve the student's course work program.

Other Relevant Information

Continuous fall and spring registration is required for all graduate students until the thesis is approved.

Student Aid

Graduate assistantships and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

AGRICULTURAL AND BIOLOGICAL ENGINEERING (A B E)

- 400. BIOLOGICAL SYSTEMS (3)
- 401. MODELLING METHODS FOR BIOLOGICAL SYSTEMS (3)
- 402. TRANSPORT PROCESSES FOR BIOLOGICAL PRODUCTION (3)
- 403. POWER AND STRUCTURAL SYSTEMS IN AGRICULTURE (3)
- 404. ENGINEERING PROPERTIES OF FOOD AND BIOLOGICAL MATERIALS (3)
- 405. AGRICULTURAL MEASUREMENTS AND CONTROL SYSTEMS (3)
- 461. DESIGN OF FLUID POWER SYSTEMS (3)
- 462. DESIGN OF WOOD STRUCTURES (3)
- 465. FOOD AND BIOLOGICAL PROCESS ENGINEERING (4)
- 467. DESIGN HYDROLOGY AND SEDIMENTOLOGY (4)
- 469W. OPTIMIZATION OF BIOLOGICAL PRODUCTION AND PROCESSING SYSTEMS (3)
- 471. ENGINEERING PRINCIPLES OF AGRICULTURAL MACHINES (1)
- 472. FUNCTIONAL DESIGN OF AGRICULTURAL BUILDINGS (1)
- 475. FOOD ENGINEERING EQUIPMENT DESIGN (3)
- 490W. AGRICULTURAL AND BIOLOGICAL ENGINEERING COLLOQUIUM (1)
- 494. SENIOR THESIS (1-9)
- 495. AGRICULTURAL ENGINEERING INTERNSHIP (1-6)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

500. RESEARCH METHODS IN AGRICULTURAL AND BIOLOGICAL ENGINEERING (3)

Introduction to research philosophies, methodologies, issues and policies; measures of research quality; research report writing; research ethics.

504. MECHANICS AND PROPERTIES OF PARTICULATE MATERIALS (3) Constitutive equations for cohesionless and cohesive particulate materials; measurement of properties; application to storage, flow, and consolidation.
512. STRUCTURAL AND ENVIRONMENTAL ANALYSIS OF AGRICULTURAL BUILDINGS (3) Advanced topics on the design and analysis of structural and environmental control systems for agricultural buildings. Prerequisites: A B E 462.
513. APPLIED FINITE ELEMENT, FINITE DIFFERENCE, AND BOUNDARY ELEMENT METHODS (3) Applications of numerical methods in the areas of structures, fluid dynamics, heat and mass transfer, machine design.
515. THERMAL PHENOMENA IN FOOD ENGINEERING (3) Heat and mass transfer phenomena, nutrient degradation rates, and energy use in food processing.
517. SURFACE TRANSPORT OF AGRICULTURAL POLLUTANTS (3) Understanding and modeling the surface transport processes of agricultural pollutants; particularly erosion, sediment transport, and movement of sediment-attached constituents.
519. CONTROL OF AGRICULTURAL PROCESSES USING MICROCOMPUTERS (1-3) Design and application of control systems for agricultural processes and equipment using microcomputers. Prerequisite: A B E 405.
559. AGRICULTURAL AND BIOLOGICAL SYSTEMS SIMULATION (3) Continuous and discrete simulation modeling of physical and biological systems, numerical simulation techniques, validation and verification, difference measures, sensitivity analysis. Prerequisites: CMPSC 101 or 201; MATH 111 or 141.
562. (EMCH) BOUNDARY ELEMENT ANALYSIS (3) Numerical solution of boundary value problems using fundamental solutions; application to problems in potential theory, diffusion, and elastostatics. Prerequisite: A B E 513, E MCH 461, or 560.
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

AGRICULTURAL ECONOMICS (AG EC)

DAVID BLANDFORD, *Head of the Department of Agricultural Economics and Rural Sociology*
103 Armsby Building
814-865-5461

Degrees Conferred: Ph.D., M.S., M.Agr.

The Graduate Faculty

Charles Abdalla, Ph.D. (Michigan State) *Associate Professor of Agricultural Economics*
David G. Abler, Ph.D. (Chicago) *Associate Professor of Agricultural Economics*
Theodore R. Alter, Ph.D. (Michigan State) *Professor of Agricultural Economics*
John C. Becker, J.D. (Dickinson) *Professor of Agricultural Economics*
James G. Beierlein, Ph.D. (Purdue) *Professor of Agricultural Economics*
David Blandford, Ph.D. (Manchester) *Professor of Agricultural Economics*
James W. Dunn, Ph.D. (Oklahoma State) *Professor of Agricultural Economics*
Donald J. Epp, Ph.D. (Michigan State) *Professor of Agricultural Economics*
Jill L. Findeis, Ph.D. (Washington State) *Associate Professor of Agricultural Economics*
Ann N. Fisher, Ph.D. (Connecticut) *Senior Research Associate*
Stephen A. Ford, Ph.D. (Minnesota) *Associate Professor of Agricultural Economics*
Darren L. Frechette, Ph.D. (N Carolina State) *Assistant Professor of Agricultural Economics*
Frank M. Goode, Ph.D. (Minnesota) *Associate Professor of Agricultural Economics*
Milton C. Hallberg, Ph.D. (Iowa State) *Professor of Agricultural Economics*
Jayson K. Harper, Ph.D. (Texas A&M) *Associate Professor of Agricultural Economics*
William L. Henson, Ph.D. (Penn State) *Assistant Professor of Agricultural Economics and Rural Sociology*
Robert O. Herrmann, Ph.D. (Michigan State) *Professor of Agricultural Economics*
Drew W. Hyman, Ph.D. (California) *Professor of Public Policy and Community Systems*
Timothy W. Kelsey, Ph.D. (Michigan) *Assistant Professor of Agricultural Economics*
Janelle B. Larson, Ph.D. (Oxford) *Assistant Professor of Agricultural Economics*

Wayne A. Schutjer, Ph.D. (Michigan State) *Professor of Agricultural Economics*
 Martin Shields, Ph.D. (Wisconsin) *Assistant Professor of Agricultural Economics*
 James Shortle, Ph.D. (Iowa State) *Professor of Agricultural Economics*
 Stephen M. Smith, Ph.D. (Wisconsin) *Associate Professor of Agricultural Economics*
 Spiro Stefanou, Ph.D. (California, Davis) *Professor of Agricultural Economics*
 Jeffrey R. Stokes, Ph.D. (Texas A&M) *Assistant Professor of Agricultural Economics*
 Robert D. Weaver, Ph.D. (Wisconsin) *Associate Professor of Agricultural Economics*

The graduate program emphasizes economic theory and analytical techniques in the fields of farm management, production economics, agricultural marketing, resource and environmental economics, rural development, agricultural policy and prices, and international agricultural trade and development.

Admission Requirements

Scores from the Graduate Record examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Students entering the master's program should have a total of 9 credits in agricultural economics and/or economics. Students entering the doctoral program should have successfully completed courses in intermediate micro- and macroeconomic theory, in differential and integral calculus and linear algebra, and in intermediate statistics. Students are permitted to enter the master's and doctoral programs with deficiencies but must pass courses to eliminate deficiencies as soon as possible.

Students with a 2.75 junior/senior grade-point average (on a 4.00 scale) and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.75 grade-point average may be made for students with special backgrounds, abilities, and interests.

Doctoral Degree Requirements

There is no foreign language requirement for the Ph.D. degree; rather, the student must satisfactorily complete courses in economic theory and quantitative methods.

Other Relevant Information

Students in this program may elect the dual-title degree program option in Operations Research for the Ph.D. and M.S. degrees.

Students may qualify for admission to the dual-title degree program option in Demography consisting of interdisciplinary course work, with special emphasis on the economic, social, and geographic issues arising from the dynamics of population change.

Student Aid

Graduate assistantships and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

AGRICULTURAL ECONOMICS (AG EC)

- 401W. ECONOMIC ANALYSIS OF ENVIRONMENTAL AND RESOURCE POLICIES (3)
- 402. LAND AND WATER RESOURCE ECONOMICS (3)
- 407. FARM PLANNING AND FINANCIAL MANAGEMENT (3)
- 410. AGRICULTURAL REAL ESTATE APPRAISAL (3)
- 420. AGRICULTURAL PRICES (3)
- 430. (COM S) PRINCIPLES OF ECONOMIC DEVELOPMENT PLANNING (3)
- 432. (COM S) TECHNIQUES OF COMMUNITY ECONOMIC DEVELOPMENT PLANNING (3)
- 450. INTERNATIONAL DEVELOPMENT, RENEWABLE RESOURCES, AND THE ENVIRONMENT (3)
- 460. ECONOMICS OF THE FOOD INDUSTRY (3)
- 461W. MANAGERIAL ECONOMICS IN AGRICULTURAL BUSINESS FIRMS (3)
- 490. SEMINAR IN AGRICULTURAL BUSINESS MANAGEMENT (3)
- 495A. INTERNSHIP IN AGRIBUSINESS AND RURAL DEVELOPMENT (1-6)
- 495B. INTERNSHIP IN INTERNATIONAL AGRIBUSINESS (6)
- 496. INDEPENDENT STUDIES (1-18)

497. SPECIAL TOPICS (1-9)

499. FOREIGN STUDY—AGRICULTURAL ECONOMICS (1-12)

501. AGRICULTURAL PRODUCTION ECONOMICS I (3) Application of microeconomic theory to problems and decisions of farm households and agricultural firms. Prerequisite: ECON 502.

502. ECONOMICS OF NATURAL RESOURCES AND RURAL DEVELOPMENT (3) Emphasis will be placed on the application of economic concepts to problems and policies in rural areas. Prerequisites: ECON 502, 503.

503. AGRICULTURAL MARKETING (3) Economic analysis of food marketing firms and institutions; identification and measurement of dimensions of market performance; public policy. Prerequisite: ECON 502.

510. (ECON) ECONOMETRICS I (3) General linear model, multicollinearity, specification error, autocorrelation, heteroskedasticity, restricted least squares, functional form, dummy variables, limited dependent variables. Prerequisite: ECON 490, STAT 462, or 501.

511. (ECON) ECONOMETRICS II (3) Stochastic regressors, distributed lag models, pooling cross-section and time-series data, simultaneous equation models. Prerequisite: AG EC (ECON) 510.

519. RESOURCE AND ENVIRONMENTAL ECONOMICS I (3) Theories and methods for economic analysis of natural resource and environmental policies with applications to current issues. Prerequisite: ECON 502.

525. RESEARCH METHODS IN RURAL SOCIAL SCIENCES (3) Scientific method in planning and conducting research. Prerequisites: 9 credits in social sciences.

527. QUANTITATIVE METHODS I (3) Quantitative techniques applied to agricultural economic issues. Prerequisites: ECON 502.

533. RURAL DEVELOPMENT RESEARCH METHODS AND TOPICS (3) Advanced theories and methods for rural economic development research. Prerequisites: AG EC 502, 511, ECON 521.

534. AGRICULTURAL PRODUCTION ECONOMICS II (3) Current problems and methods of analysis in production economics research. Prerequisites: AG EC 511, 527, ECON 521.

536. AGRICULTURAL COMMODITY MARKETS (3) Specification, identification, and estimation of models for use in the evaluation and control of agricultural market behavior. Prerequisite: AG EC (ECON) 510, 511, or ECON 521.

538. POLICY FOR THE FOOD AND AGRICULTURE SECTOR (3) Policy formation; policies for food and agriculture, consequences for farmers, consumers, resources; farm program benefits and costs; current issues. Prerequisites: AG EC (ECON) 511, ECON 521, ECON 522.

539. INTERNATIONAL AGRICULTURAL TRADE (3) Analysis of determinants, institutions, and policy control of agricultural trade. Role of agricultural trade in the general economy and development. Prerequisite: ECON 502.

541. RESOURCES AND ENVIRONMENTAL ECONOMICS II (3) Key theories and analytical methods of resource and environment economics. Prerequisites: AG EC 511, 519, ECON 521.

550. INTERNATIONAL ECONOMIC DEVELOPMENT AND AGRICULTURE (3) The economic development process with particular emphasis on agriculture. Prerequisite: ECON 502.

589. (ECON) SEMINAR IN ECONOMETRIC THEORY (3) Theories and methods relevant to the application of statistical methods to economics. Prerequisite: AG EC (ECON) 510, 511.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

AGRICULTURAL EDUCATION (AG ED)

BLANNIE E. BOWEN, *Head of the Department*

323 Agricultural Administration Building

814-865-1688

Degrees Conferred: Ph.D., D.Ed., M.S., M.Ed.

The Graduate Faculty

Phyllis F. Adams, Ph.D. (Oklahoma State) *Associate Professor of Agricultural and Extension Education*

Connie D. Baggett, Ph.D. (Penn State) *Associate Professor of Agricultural and Extension Education*

Blannie E. Bowen, Ph.D. (Ohio State) *Professor of Agricultural and Extension Education*

Cathy F. Bowen, Ph.D. (Ohio State) *Assistant Professor of Agricultural and Extension Education*
 Thomas H. Bruening, Ph.D. (Iowa State) *Associate Professor of Agricultural and Extension Education*
 Donald E. Evans, D.Ed. (Penn State) *Associate Professor of Agricultural and Extension Education*
 Constance A. Flanagan, Ph.D. (U Michigan) *Associate Professor of Agricultural and Extension Education*
 Patreese D. Ingram, Ed.D. (Western Michigan) *Assistant Professor of Agricultural and Extension Education*
 Robert B. Lewis, Ed.D. (North Carolina State) *Professor of 4-H Youth*
 James H. Mortensen, Ph.D. (Penn State) *Professor of Agricultural Education*
 Timothy J. Rollins, Ph.D. (Iowa State) *Associate Professor of Agricultural and Extension Education*
 Tena L. St. Pierre, Ph.D. (Penn State) *Associate Professor of Agricultural and Extension Education*
 Dennis C. Scanlon, Ph.D. (Ohio State) *Professor of Agricultural and Extension Education*
 Jan F. Scholl, Ph.D. (Iowa State) *Associate Professor of Agricultural and Extension Education*
 Joan S. Thomson, Ph.D. (Wisconsin) *Associate Professor of Rural Sociology*
 Barbara K. Wade, Ph.D. (Penn State) *Affiliate Associate Professor of Agricultural and Extension Education*
 M. Susie Whittington, Ph.D. (Ohio State) *Assistant Professor of Agricultural and Extension Education*
 Edgar P. Yoder, Ph.D. (Ohio State) *Professor of Agricultural and Extension Education*

Graduate programs emphasize agricultural or extension education (including preparation for employment in college or university programs), youth and family programming, state-level administration, local-level administration, private industry and international education. A minor may be taken in an area of the student's choice or in general studies. Programs may include courses needed for certification in other fields of education.

Admission Requirements

All applicants must submit a letter of application, two or three typewritten pages in length, describing their professional experience, education, career goals, and reasons for pursuing the degree. Applicants must ensure that three departmental recommendation and evaluation forms from individuals knowledgeable about the applicant are forwarded to the department. Only the most qualified applicants will be admitted to the graduate program. The graduate program may provisionally admit selected applicants pending resolution of the requirements listed here or applicants with special skills and experiences. Requirements listed here are in addition to the general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Master's Degrees: Prerequisite for admission to a master's program is a demonstrated professional interest in agricultural and extension education and/or applied youth and family development. Applicants should have a minimum grade-point average of 2.80 on a 4.00 scale for the junior and senior years of their baccalaureate degree or a minimum combined score of 800 on the verbal and quantitative sections of the Graduate Record Examination (GRE).

Master of science: This program is intended for those who are interested in defining, developing, or evaluating educational programs, both formal or nonformal, through public and private agencies and organizations serving youth, families or the agriculture community.

Master of education: Prerequisite for admission to this program is a minimum of 18 credits in professional education courses (including educational psychology and teaching and/or professional internship) or certification as a teacher of agriculture, or equivalent professional experience, including extension.

Doctoral Degrees: An applicant should have a minimum average of 3.40 on a 4.00 scale on all previous graduate work or a minimum combined score of 1000 on the verbal and quantitative sections of the GRE. Two years of appropriate professional experience is required either prior to admission or before the degree is awarded. An interview with the graduate faculty is recommended of all applicants prior to admission into a doctoral program. Applicants to the doctoral program must submit evidence of ability to write a scholarly paper or thesis and demonstrate a teaching-level competence of English.

Master's Degree Requirements

A program of study agreement between adviser and student, including planned course work (approved by the student's committee) and time frame, should be completed before beginning the second semester of study. Successful performance on a four-hour written essay exam, plus a one-hour oral exam, is required of all M.S. and M.Ed. candidates near the completion of their course work for the degree. The master's candidate is required to successfully complete an oral defense of a paper or thesis.

Doctoral Degree Requirements

Two years of appropriate professional experience is required either prior to admission or before the doctoral degree is completed.

Other Relevant Information

Selection and appointment of a thesis adviser and doctoral committee follows admission to candidacy. The candidate consults the department head or graduate officer in selecting an adviser. The candidate, in cooperation with an adviser, selects the doctoral committee. The chair of the committee is not necessarily the thesis adviser, but the thesis adviser is a member of the committee.

Student Aid

Graduate assistantships and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

AGRICULTURAL EDUCATION (AG ED)

400. EDUCATIONAL PROGRAMS IN AGRICULTURE FOR DEVELOPING COUNTRIES (3)

412. METHODS OF TEACHING AGRICULTURE* (4)

413. ADVANCED METHODOLOGY IN AGRICULTURAL EDUCATION* (2)

418. SURVEY OF VOCATIONAL EDUCATION IN AGRICULTURE (1-4)

424. OCCUPATIONAL GUIDANCE IN AGRICULTURAL INDUSTRY* (1-4)

426. ADULT EDUCATION IN AGRICULTURE (1-4)

434. AGRICULTURAL DEVELOPMENTS (1-6)

440. (EXTED) COMMUNICATION METHODS AND MEDIA (3)

450. (EXTED) METHODOLOGY OF EXTENSION EDUCATION (3)

490. COLLOQUIUM (1-3)

495. STUDENT TEACHING IN AGRICULTURE* (1-15)

496. INDEPENDENT STUDIES (1-8)

497. SPECIAL TOPICS (1-9)

501. AGRICULTURAL EDUCATION IN THE UNITED STATES (1-3) Historical development, social and philosophical foundations, and current status in relation to the total vocational-technical education program.

502. TEACHING AGRICULTURE (1-3) Vocational education objectives, learning theory, class instruction, cooperative occupational experience, and evaluation.

508. ADMINISTRATION AND SUPERVISION OF AGRICULTURAL EDUCATION II (1-2) Basics of vocational funding, supervision, leadership, and management for agricultural education.

509. TEACHER EDUCATION IN AGRICULTURE (1-6) Organization and administration of university programs of teacher education in agriculture, including preservice preparation, continuing education, research and other services.

520. SCIENTIFIC METHOD IN THE STUDY OF AGRICULTURAL EDUCATION (1-4) Methods of procedure in investigation and experimentation in education, accompanied by a critical examination of studies made in agricultural education.

521. SCIENTIFIC METHOD IN THE STUDY OF AGRICULTURAL EDUCATION (1-4) Continuation of AG ED 520; emphasis upon statistical techniques for students' individual problems.

524. PROGRAM DEVELOPMENT IN AGRICULTURAL EDUCATION (1-3) Analysis of occupational needs of students and employment prospects; organization of courses of study and other activities of teachers.

530. AGRICULTURAL COLLEGE TEACHING (3-4) Organization, planning, and delivery of effective teaching methods, matching teaching/learning styles, evaluation of instruction and learning.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

AGRONOMY (AGRO)

S. L. FALES, *Head of the Department*
116 Agricultural Sciences and Industries Building
814-865-6541

Degrees Conferred: Ph.D., M.S., M.Agr.

The Graduate Faculty

Dale E. Baker, Ph.D. (Missouri) *Professor Emeritus of Soil Chemistry*
Douglas B. Beegle, Ph.D. (Penn State) *Professor of Agronomy*
Jean-Marc Bollag, Ph.D. (Basel) *Professor of Soil Microbiology*
Jon D. Chorover, Ph.D. (California, Berkeley) *Assistant Professor of Environmental Soil Chemistry*
Edward J. Ciolkosz, Ph.D. (Wisconsin) *Professor of Soil Genesis and Morphology*
Robert L. Cunningham, Ph.D. (Washington State) *Professor Emeritus of Soil Genesis and Morphology*
William S. Curran, Ph.D. (Illinois) *Associate Professor of Weed Science*
Rick L. Day, Ph.D. (Penn State) *Assistant Professor of Soil Science and Environmental Information Systems*
Joseph M. Duich, Ph.D. (Penn State) *Professor Emeritus of Turfgrass Science*
Steven L. Fales, Ph.D. (Purdue) *Professor of Agronomy*
Richard H. Fox, Ph.D. (Arizona) *Professor of Soil Science*
Daniel D. Fritton, Ph.D. (Iowa State) *Professor of Soil Physics*
David L. Gustine, Ph.D. (Michigan State) *Adjunct Associate Professor of Crop Physiology*
Jon K. Hall, Ph.D. (Penn State) *Associate Professor of Soil Chemistry*
Marvin H. Hall, Ph.D. (Minnesota) *Associate Professor of Forage Management*
Nathan L. Hartwig, Ph.D. (Wisconsin) *Professor of Weed Science*
O. Elwood Hatley, Ph.D. (Purdue) *Professor of Agronomy*
David R. Huff, Ph.D. (California) *Assistant Professor of Turfgrass Breeding*
Leon J. Johnson, Ph.D. (Penn State) *Professor Emeritus of Soil Mineralogy*
Melvin W. Johnson, Ph.D. (Wisconsin) *Associate Professor of Plant Breeding*
Heather D. Karsten, Ph.D. (Cornell) *Assistant Professor of Crop Production/Ecology*
Daniel P. Knievel, Ph.D. (Wisconsin) *Associate Professor of Crop Physiology*
Sridhar Komarneni, Ph.D. (Wisconsin) *Professor of Clay Mineralogy*
Charles R. Krueger, Ph.D. (Wisconsin) *Professor of Agronomy*
Peter J. Landschoot, Ph.D. (Rhode Island) *Associate Professor of Turfgrass Science*
Les E. Lanyon, Ph.D. (Ohio State) *Professor of Soil Fertility*
Charles F. Mancino, Ph.D. (Massachusetts) *Associate Professor of Turf/Soil Science*
Egide Nizeyimana, Ph.D. (Illinois) *Senior Research Associate*
Gary W. Petersen, Ph.D. (Wisconsin) *Professor of Soil and Land Resources*
Harry B. Pionke, Ph.D. (Wisconsin) *Adjunct Professor of Soil Science*
Marvin L. Risius, Ph.D. (Cornell) *Professor of Plant Breeding*
Andrew S. Rogowski, Ph.D. (Iowa State) *Adjunct Professor of Soil Physics*
Gregory W. Roth, Ph.D. (Penn State) *Associate Professor of Corn Management*
Ronald R. Schnabel, Ph.D. (Washington State) *Adjunct Assistant Professor of Soil Science*
Andrew N. Sharpley, Ph.D. (Massey, New Zealand) *Adjunct Professor of Soil Science*
John S. Shenk, Ph.D. (Michigan State) *Professor of Plant Breeding*
James L. Starling, Ph.D. (Penn State) *Professor Emeritus of Agronomy*
Richard C. Stehouwer, Ph.D. (Ohio State) *Assistant Professor of Environmental Soil Science*
William L. Stout, Ph.D. (Penn State) *Adjunct Assistant Professor of Soil Science*
A. J. Turgeon, Ph.D. (Michigan State) *Professor of Agronomy*
Donald V. Waddington, Ph.D. (Massachusetts) *Professor Emeritus of Soil Science*
Thomas L. Watschke, Ph.D. (Virginia Polytechnic) *Professor of Turfgrass Science*

Agronomy graduate programs emphasize research that increases the efficiency of production of agro-nomic crops, improves the quality of food, feed, and fiber available for humans and animals, assists in the use and development of land resources, develops an understanding of the basic soil-plant-animal climate

complex of which humans are a part, and improves the overall quality of the human environment. Within this framework, students may specialize in soil science, crop science, or soil and crop management, including turfgrass management. Areas of specialization in soil science include chemistry, fertility, genesis and morphology, microbiology, mineralogy, and physics. Crop science specialties include breeding and genetics, ecology and management, physiology, and weed science.

Research facilities include a 340-acre experimental farm with irrigation facilities, a 22-acre turfgrass research center, and 18-acre landscape management research center, greenhouses, service areas, and a number of well-equipped experimental laboratories. The department enjoys close collaboration with the USDA Pasture Systems and Watershed Management Research Laboratory, which adds substantial strength to the research and graduate education capabilities of the department.

Admission Requirements

Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination, are required for admission. At the discretion of the graduate standards committee, a student may be admitted provisionally for graduate study in the program without these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Prerequisites for major work in agronomy vary with the area of specialization and the degree sought, but courses in chemistry, mathematics, physics, geology, basic and applied biological sciences, and English communication skills are required. Applicants for the M.S. degree should have a baccalaureate degree including 76 credits of basic and applied natural sciences. For the M.Agr. degree program, an applicant must present a baccalaureate degree in agricultural or forest science.

A minimum junior/senior grade-point average 3.00 (on a 4.00 scale) is required in all courses in the biological and physical sciences regardless of when taken. Exceptions to these requirements may be made for students with special backgrounds, abilities, and interests.

Admission to the Ph.D. program requires an M.S. or equivalent degree, and 100 credits (including credits of the baccalaureate degree) of basic and applied natural sciences. Applicants for the Ph.D. program will be evaluated on the quality of work completed in all previous degree programs.

Students who lack some of the prerequisite courses may be admitted but are required to take these courses without degree credit. The best-qualified applicants will be accepted up to the number of spaces available for new students.

Master's Degree Requirements

In addition to the general requirements for the M.S. degree as defined by the Graduate School, the department requires 6 credits of 400- or 500-level formal courses in a minor or general studies area. Participation in at least one Agronomy seminar course each semester is required, and students must register for at least 1 credit of an Agronomy seminar. An advisory committee will be appointed for each student, and additional courses and requirements may be determined by this advisory committee.

A thesis based on field and/or laboratory research is required for the M.S. degree. Candidates for the M.Agr. degree may prepare a paper based on library research in lieu of a thesis.

Both M.S. and M.Agr. candidates must pass a final examination.

Doctoral Degree Requirements

Beyond the general requirements for the Ph.D. defined by the Graduate School, the department has a number of specific requirements regarding course level and distribution that are defined in the departmental publication "Graduate Degrees in Agronomy." While a minimum number of courses for the degree is not specified, the doctoral advisory committee has the responsibility of specifying courses and credits essential for the education and development of the candidate. Students are expected to be educated in depth in a specific subfield of agronomy and to have a perspective of the general field. Normally, 55 to 60 credits in formal course work beyond the B.S. degree are required. Doctoral candidates are required to participate regularly in a departmental seminar and to register for at least 2 credits of the seminar during the Ph.D. program.

The communication and foreign language requirement for the Ph.D. degree may be met either by demonstrating a knowledge of at least one foreign language or by completing at least 6 credits of course work in an area of English communications approved by the student's advisory committee.

In addition to the candidacy, comprehensive, and final oral examinations, the department requires a competency examination to be taken after a student passes the candidacy. The purpose of this examination is to determine the student's strengths and weaknesses in pertinent subject matter and to assist the advisory committee in providing direction relative to required course work.

Other Relevant Information

Every student has a close professional relationship with his or her faculty adviser. While research that is done for the thesis will be on subjects that fall within the ongoing research program of the adviser, students are encouraged to propose research projects that are of interest to them. For the most part, all costs relative to the research program will be covered by the department. The department encourages professional development of students through participation in meetings of relevant professional societies and organizations.

Student Aid

Graduate assistantships and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

AGRONOMY (AGRO)

See also Soil Science.

403. (SOILS) PROPERTIES AND MANAGEMENT OF TROPICAL SOILS (2)

410W. CROP SCIENCE (4)

423. FORAGE CROP MANAGEMENT (3)

425. FIELD CROP MANAGEMENT (3)

438A. PRINCIPLES OF WEED CONTROL AND HERBICIDE PROPERTIES (4)

438B. WEED IDENTIFICATION (2)

489. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3)

490. (SOILS) COLLOQUIUM (1-3)

495. INTERNSHIP

496. INDEPENDENT STUDIES (1-9)

497. SPECIAL TOPICS (1-9)

501. SOIL FERTILITY (3) Soil-plant relations emphasizing recent concepts of ion accumulation by plants as affected by soil conditions and plant physiology. Prerequisites: BIOL 441, SOILS 402.

511. BIOMETRICAL PLANT BREEDING (3) Quantitative genetics of plant populations; application to breeding methodology and selection. Prerequisites: AGRO 512; 3 credits in plant breeding.

512. FIELD PLOT TECHNIQUE (4) Ramifications of analysis of variance techniques; combining and analyzing data from several experiments; selection of valid error terms. Prerequisite: AG 400 or STAT 200.

515. NUTRITIVE VALUE OF CROP PLANTS (3) Biochemical, physiological, genetic, and morphological nature of crop plants related to animal response. Laboratory includes nutritive evaluation procedures. Prerequisites: 3 credits of crop production and 6 credits of biochemistry and/or nutrition.

517. CROP ECOLOGY AND PHYSIOLOGY (3) Ecological and physiological factors affecting the productivity of crop plants. Prerequisite: AGRO 410.

518. RESPONSES OF CROP PLANTS TO ENVIRONMENTAL STRESS (3) Physiological and ecological aspects of the response of crop plants to environmental stresses in establishment, persistence, and reproduction. Prerequisite: AGRO 410.

545. THE APPLICATION OF STATISTICS TO FIELD EXPERIMENTS (4) Use of advanced experimental designs in planning, analyzing, and interpreting experiments; includes lattice designs, factorials, confounding, simple and multiple covariance techniques. Prerequisite: AGRO 512.

590. (SOILS) AGRONOMY COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

AMERICAN STUDIES (AMSTD)

SIMON J. BRONNER, Coordinator, Graduate Program in American Studies

Penn State Harrisburg

777 W. Harrisburg Pike

Middletown, PA 17057-4898

717-948-6201

Degree Conferred: M.A.

The Graduate Faculty

Michael L. Barton, Ph.D. (Pennsylvania) *Associate Professor of Social Science and American Studies*
 Simon J. Bronner, Ph.D. (Indiana) *Distinguished Professor of Folklore and American Studies*
 Eton F. Churchill, M.F.A. (Tulane) *Assistant Professor of Humanities and Communications*
 Theodora R. Graham, Ph.D. (Pennsylvania) *Associate Professor of Humanities and English*
 Allison Duncan Hirsch, Ph.D. (Columbia) *Assistant Professor of American Studies and History*
 William J. Mahar, Ph.D. (Syracuse) *Professor of Humanities and Music*
 John S. Patterson, Ph.D. (Brown) *Associate Professor of American Studies and History*
 Irwin Richman, Ph.D. (Pennsylvania) *Professor of American Studies and History*
 Matthew Wilson, Ph.D. (Rutgers) *Associate Professor of Writing and Humanities*

This program, offered at Penn State Harrisburg, emphasizes the interdisciplinary study of American society and culture. It provides the student with the opportunity to acquire knowledge in the fields of history, literature, media, material culture, museology, folklore, art, architecture, music, and to study the interrelationships linking those fields with important questions and issues in American life.

Strong ties with local educational and cultural institutions, including the State Museum of Pennsylvania, Pennsylvania Farm Museum of Landis Valley, Hershey Museum of American Life, and the Dauphin County Historical Society, provide excellent learning opportunities for interested students.

This degree can be earned by full- or part-time study. As a convenience for working students, all 500-level courses are offered in the evening, and every attempt is made to meet the student's individual needs.

Admission Requirements

Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

There are no course work prerequisites for admission to the master's program; however, a student must have received a baccalaureate degree from an accredited institution, earned under residence and credit conditions substantially equivalent to those required by Penn State. The application, transcripts, two letters of recommendation, and a 1,000- to 1,500-word essay outlining personal goals and reasons for applying for admission to the program should be sent to Penn State Harrisburg, Graduate Office, 777 W. Harrisburg Pike, Middletown, PA 17057-4898. Submit materials for fall admission before February 15 and for spring admission before October 15.

Degree Requirements

The student is required to take a minimum of 30 credits, including at least 18 credits in the 500 series; AMSTD 500 and 580 are required. An original scholarly master's paper or a creative project or a specialized examination is required for graduation. One to 6 credits in AMSTD 580 can be earned during work on the master's project.

Student Aid

Graduate assistantships and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

AMERICAN STUDIES (AMSTD)

500. THEORY AND METHODS (3) Introduction to graduate work in American Studies through exploration of the approaches, materials, and interpretation of the field.

511. PIVOTAL BOOKS (3-9) Exploration of a number of books which have been particularly influential in shaping thinking about American Civilization.

530. TOPICS IN AMERICAN FOLKLORE (3) A detailed exploration of aspects of folklore and folklife in America.

533. AMERICAN CIVILIZATION IN THE EIGHTEENTH CENTURY (3-9) Detailed investigation of specific topics in eighteenth-century American civilization.

534. AMERICAN CIVILIZATION IN THE NINETEENTH CENTURY (3-9) Representative interdisciplinary investigation of social, historical, economic, and aesthetic forces predominant in nineteenth-century America.

535. AMERICAN CIVILIZATION IN THE TWENTIETH CENTURY (3-9) Detailed investigation of specific periods or topics in twentieth-century American civilization.

570. TOPICS IN AMERICAN ART (1-6) Various themes within the American arts will be explored under this rubric.

575. MUSEUM INTERNSHIP (3) A supervised museum internship experience featuring a "hands-on" introduction into aspects of the curatorial profession. Prerequisite: permission of instructor.

580. PROJECTS IN AMERICAN STUDIES (1–6) Independent exploration within American Studies; evidenced by major paper, film, exhibition or specialized examination.
590. COLLOQUIUM (1–3)
591. SEMINAR (3)
596. INDIVIDUAL (1–9)
597. SPECIAL TOPICS (1–9)

ADDITIONAL COURSES may be taken from the following list of American Studies courses and from 400-level courses in other fields with the concurrence of the student's adviser. Descriptions of these courses can be found in the *Penn State Harrisburg Bulletin*.

400. EARLY AMERICA, 1620–1828 (3)
403. AMERICAN IDEAS (3)
411. WOMEN IN AMERICAN SOCIETY (3)
422. WESTWARD MOVEMENT (3)
431. THE AMERICAN CHARACTER (3)
442. AMERICAN FOLKLORE (3)
451. CIVIL WAR AND RECONSTRUCTION (3)
452. THE AMERICAN RENAISSANCE (3)
453. INDUSTRIAL AMERICA (3)
454. PARTIES AND POLITICS IN AMERICA (3)
455. AMERICANS AT WORK (3)
456. MASS CULTURE: THE POPULAR ARTS IN AMERICA (3)
457. ETHNIC AMERICA (3)
458. CONTEMPORARY AMERICA, 1945–PRESENT (3)
459. AMERICA'S COMING OF AGE 1914–1939 (3)
460. AMERICAN ART AND ARCHITECTURE (3)
462. MODERN ART AND ARCHITECTURE (3)
463. AMERICAN MUSIC (3)
469. AMERICAN INDIANS (3)
470. REGIONALISM IN AMERICA (3)
480. MUSEUMS AND CULTURE (3)
491. SEMINAR IN AMERICAN CULTURE (3)
495. INTERNSHIP (1–6)
496. INDEPENDENT STUDIES (1–18)
497. SPECIAL TOPICS (1–9)

ANATOMY (ANAT)

ROBERT J. MILNER, *Chair of the Department of Neuroscience and Anatomy*
 College of Medicine, University Hospital
 The Milton S. Hershey Medical Center
 Hershey, PA 17033
 717-531-8650

Degrees Conferred: Ph.D., M.S.

The Graduate Faculty

Kevin Alloway, Ph.D. (Indiana) *Associate Professor of Neuroscience and Anatomy*
 James R. Connor, Ph.D. (California, Berkeley) *Professor of Neuroscience and Anatomy*
 Steven P. Dear, Ph.D. (Pennsylvania) *Assistant Professor of Neurosciences and Anatomy*
 Ellen J. Hess, Ph.D. (California, San Diego) *Associate Professor of Neuroscience and Anatomy*
 Alphonse E. Leure-duPree, Ph.D. (London) *Professor of Neuroscience and Anatomy*
 Erich Lieth, Ph.D. (North Carolina, Chapel Hill) *Assistant Professor of Neuroscience and Anatomy*
 Steve Levison, Ph.D. (North Carolina, Chapel Hill) *Assistant Professor of Neuroscience and Anatomy*
 Patricia McLaughlin, D.Ed. (Penn State) *Associate Professor of Neuroscience and Anatomy*
 Robert J. Milner, Ph.D. (Rockefeller) *Professor of Neuroscience and Anatomy*
 Robert B. Page, M.D. (Columbia) *Professor of Neurosurgery and Neuroscience and Anatomy*
 Teresa Wood, Ph.D. (UCLA) *Assistant Professor of Neuroscience and Anatomy*
 Susan Vannucci, Ph.D. (Penn State) *Associate Professor of Pediatrics, and Neuroscience and Anatomy*
 Ian S. Zagon, Ph.D. (Colorado) *Professor of Neuroscience and Anatomy*

The graduate program emphasizes the general areas of gross anatomy, history, histology/cytology, neuroanatomy/neurophysiology, or appropriate combinations of these areas. Approaches offered include morphological (descriptive, comparative, developmental), functional (physiological, chemical), and experimental.

Admission Requirements

Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

A bachelor's degree reflecting a reasonable background in zoology, biology, mathematics, or chemistry is required. Students with a 3.00 junior/senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests. Applicants must provide complete transcripts and two letters of recommendation. A personal interview is desirable.

Doctoral Degree Requirements

The communication and foreign language requirement for the Ph.D. degree may be satisfied by intermediate knowledge of one foreign language.

Other Relevant Information

This program is offered only at The Milton S. Hershey Medical Center.

Student Aid

Graduate assistantships and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

ANATOMY (ANAT)

503. GROSS ANATOMY (6) Gross structure, organization, and function of the human body, with laboratories devoted to dissection of the human body.

505. HISTOLOGY AND EMBRYOLOGY I (2) Light and electron microscopic structure of cells, specialized tissues, organization, basic organogenesis, correlation between cellular structure and physiological function.

506. HISTOLOGY AND EMBRYOLOGY II (2) Continuation of ANAT 505; microscopic structure of cells, specialized tissues, organization, basic organogenesis, correlation between cellular structure and physiological function. Prerequisite: ANAT 505.

511. (NEURO) NEUROBIOLOGY II (3) Structure and physiology of central and peripheral nervous system, including specific sense organs.

512. HUMAN EMBRYOLOGY AND TERATOLOGY (2) Study of developing human embryo, including gamete production and fusion, implantation, organogenesis, and major abnormalities of organ systems.

515. (NEURO) DEVELOPMENTAL NEUROBIOLOGY (2) Development of the nervous system in all aspects.

530. DISSECTION (2-4) Intensive laboratory study of selected regions of the human body. Coverage and credit arranged by consultation.

542. COMPARATIVE NEUROLOGY (3) Topics in functional anatomy and neurophysiology. The comparative approach to the organization of the mammalian nervous system will be stressed. Prerequisite: ANAT 511 or NEURO 511.

543. SENSORY PROCESSES (3) Morphological, physiological, and psychophysical aspects of mammalian sensory systems; emphasizing somatic, sensory, visual, and auditory systems. Prerequisite: ANAT 511 or NEURO 511.

544. DEVELOPMENT AND REGENERATION OF THE NERVOUS SYSTEM (3) Current problems in both development and regeneration in the nervous system based on research problems encountered in the literature. Prerequisites: neurobiology, microscopic anatomy, and biological chemistry.

545. COMPARATIVE AUDITORY AND VISUAL ANATOMY (3) An introduction to the morphology and evolution of the vertebrate eye and ear; individualized laboratory work arranged by consultation.

546. (CMBIO) CONCEPTS OF DEVELOPMENT (2) This course evaluates developmental processes at the cellular and molecular level, with an emphasis on the regulatory mechanisms involved.
550. (CMBIO) QUANTITATIVE OPTICS AND CYTOLOGY (3) Study of the various types of light microscopy instruments and application of these tools to quantitative measurements in biological systems.
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-3)
597. SPECIAL TOPICS (1-9)

ANIMAL SCIENCE (AN SC)

TERRY D. ETHERTON, *Head of the Department of Dairy and Animal Science*
324 Henning Building
814-863-3665

Degrees Conferred: Ph.D., M.S., M.Agr.

The Graduate Faculty

Guy F. Barbato, Ph.D. (Virginia Polytechnic) *Associate Professor of Poultry Science*
Craig R. Baumrucker, Ph.D. (Purdue) *Professor of Animal Nutrition/Physiology*
Erskine H. Cash, Ph.D. (Michigan State) *Professor of Animal Science*
John W. Comerford, Ph.D. (Georgia) *Associate Professor of Dairy and Animal Science*
Daniel R. Deaver, Ph.D. (West Virginia) *Professor of Animal Science*
Clair C. Engle, Ph.D. (Georgia) *Associate Professor of Animal Science*
Terry D. Etherton, Ph.D. (Minnesota) *Distinguished Professor of Animal Nutrition*
Daniel R. Hagen, Ph.D. (Illinois) *Professor of Animal Science*
George L. Hargrove, Ph.D. (North Carolina State) *Professor of Dairy Science*
Harold W. Harpster, Ph.D. (Michigan State) *Associate Professor of Animal Nutrition*
C. William Heald, Ph.D. (Virginia Polytechnic) *Professor of Dairy Science*
Arlyn J. Heinrichs, Ph.D. (Ohio State) *Professor of Dairy and Animal Science*
William R. Henning, Ph.D. (Kentucky) *Associate Professor of Animal Science*
Lisa A. Holden, Ph.D. (Penn State) *Assistant Professor of Dairy and Animal Science*
R. Michael Hulet, Ph.D. (Texas A&M) *Associate Professor of Poultry Science; Interim Head, Poultry Science*
Ronald S. Kensinger, Ph.D. (Florida) *Associate Professor of Animal Nutrition/Physiology*
Kenneth B. Kephart, Ph.D. (Penn State) *Associate Professor of Animal Science*
Gary J. Killian, Ph.D. (Penn State) *Professor of Reproductive Physiology*
Roland M. Leach, Ph.D. (Cornell) *Professor of Poultry Science*
Magdi M. Mashaly, Ph.D. (Wisconsin) *Associate Professor of Poultry Science*
Edward W. Mills, Ph.D. (Purdue) *Associate Professor of Dairy and Animal Science*
Lawrence D. Muller, Ph.D. (Purdue) *Professor of Dairy Science*
Michael L. O'Connor, Ph.D. (Virginia Polytechnic) *Professor of Dairy Science*
Paul H. Patterson, Ph.D. (Wisconsin) *Associate Professor of Poultry Science*
Gary W. Rogers, Ph.D. (North Carolina State) *Associate Professor of Dairy and Animal Science*
William B. Roush, Ph.D. (Oregon State) *Associate Professor of Poultry Science*
Gabriella A. Varga, Ph.D. (Maryland) *Professor of Animal Science*
Regina Vasilatos-Younken, Ph.D. (Penn State) *Associate Professor of Poultry Science*
Paul J. Wangsness, Ph.D. (Iowa State) *Professor of Animal Nutrition*
Lowell L. Wilson, Ph.D. (South Dakota State) *Professor of Animal Science*

Students may specialize in animal care and management, breeding and genetics, growth and development, lactational biology, nutrition, or reproductive biology. Well-equipped research laboratories and various agricultural animals, as well as small-animal models and wildlife species, are available.

Admission Requirements

Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*. Prerequisite to graduate work is the completion of an undergraduate major in animal science, dairy science, poultry science, or a related biological science.

Scores from the Graduate Record Examination (GRE) are required for admission (average percentile at least 50 percent in verbal, quantitative, and analytical components). The quantitative reasoning

component is recommended, but the program will accept scores from the mathematical reasoning component. Students with a 3.00 junior/senior grade-point average (on a 4.00 scale) and with appropriate course backgrounds will be considered for admission on a competitive basis.

Exceptions to admission requirements may be made for students with special backgrounds, abilities, and interests.

Degree Requirements

The M.Agr. is a professional program designed to prepare individuals for specialist and management positions in county agricultural extension, government, or industry and does not require a thesis. The academic M.S. and Ph.D. programs require a thesis and are designed for those primarily interested in education and research. The requirements of these programs are detailed in the departmental publication "Graduate Student Handbook—Animal Science." The communication or foreign language requirement for the Ph.D. degree may be satisfied by competence in either one foreign language or communication skills.

Student Aid

Fellowships, traineeships, graduate assistantships, and other forms of financial aid are described in the STUDENT AID section of the *Graduate Bulletin*.

ANIMAL SCIENCE (AN SC)

- 400. APPLICATION OF MANAGEMENT PRINCIPLES (1)
- 406. ADVANCED SWINE MANAGEMENT (1)
- 407. ADVANCED HORSE MANAGEMENT (3)
- 409. ADVANCED BEEF CATTLE, SHEEP, AND GOAT MANAGEMENT (2)
- 410. ADVANCED DAIRY CATTLE MANAGEMENT (4)
- 411. ADVANCED POULTRY MANAGEMENT (2)
- 420. ANIMAL NUTRITION AND FEED TECHNOLOGY (4)
- 422. DAIRY CATTLE EVALUATION AND SELECTION (3)
- 423. COMPARATIVE PHYSIOLOGY OF DOMESTIC ANIMALS (3)
- 424. LIVESTOCK BREEDING EVALUATION AND SELECTION (3)
- 425. PRINCIPLES OF AVIAN DISEASES (3)
- 426. ADVANCED JUDGING AND SELECTION (2-4)
- 427. MILK SECRETION (3)
- 431W. PHYSIOLOGY OF REPRODUCTION IN FARM ANIMALS (3)
- 432. TECHNIQUES IN CATTLE REPRODUCTION (1)
- 442. QUANTITATIVE INHERITANCE AND ANIMAL BREEDING (3)
- 450. DAIRY FARM MANAGEMENT SYSTEMS (3)
- 455. ANIMAL GENETICS (2)
- 490. ANIMAL SCIENCE COLLOQUIUM (1)
- 496. INDEPENDENT STUDIES (1-18)

502. SCIENTIFIC SCHOLARSHIP (2) Consideration of the scientific method and thinking relative to scholarship, grantsmanship, and the mechanism of grantsmanship.

506. RUMINOLOGY (3) Physiological, biochemical, and microbiological activities occurring within the rumen, and the relation of rumen function to animal response. Prerequisites: at least one course in each of the following areas: Animal Nutrition, Physiology, Microbiology, and Biochemistry.

514. ANIMAL GROWTH AND DEVELOPMENT (3) Cellular, metabolic, and nutritional aspects of fetal and postnatal tissue growth; role of the endocrine system in regulation of animal growth. Prerequisites: 3 credits in biochemistry; 3 credits in physiology.

515. ADVANCED PHYSIOLOGY OF REPRODUCTION IN FARM ANIMALS (1-6) Advanced physiology of reproduction in farm animals. Prerequisite: 3 credits in physiology.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-9)

597; 598. SPECIAL TOPICS (1-9)

ANTHROPOLOGY (ANTH)

DEAN R. SNOW, *Head*
 Department of Anthropology
 409 Carpenter Building
 814-865-2509
 814-863-1474 (fax)

Degrees Conferred: Ph.D., M.A.

The Graduate Faculty

Stephen J. Beckerman, Ph.D. (New Mexico) *Associate Professor of Anthropology*
 E. Paul Durrenberger, Ph.D. (Illinois, Urbana-Champaign) *Professor of Anthropology*
 James W. Hatch, Ph.D. (Penn State) *Associate Professor of Anthropology*
 Alexander H. Joffe, Ph.D. (U Arizona) *Assistant Professor of Anthropology and Jewish Studies*
 Patricia L. Johnson, Ph.D. (Michigan) *Associate Professor of Anthropology and Women's Studies*
 Jeffrey A. Kurland, Ph.D. (Harvard) *Associate Professor of Anthropology and Human Development*
 George R. Milner, Ph.D. (Northwestern) *Professor of Anthropology*
 Warren T. Morrill, Ph.D. (Chicago) *Professor of Anthropology*
 William T. Sanders, Ph.D. (Harvard) *Evan Pugh Professor Emeritus of Anthropology*
 Dean R. Snow, Ph.D. (U Oregon) *Professor and Head of Anthropology*
 Mark Stoneking, Ph.D. (California, Berkeley) *Associate Professor of Anthropology*
 Alan Walker, Ph.D. (U London) *Professor of Anthropology and Biology*
 David L. Webster, Ph.D. (Minnesota) *Professor of Anthropology*
 Gary S. Webster, Ph.D. (Penn State) *Associate Professor of Anthropology*
 Kenneth M. Weiss, Ph.D. (Michigan) *Distinguished Professor of Anthropology and Genetics*
 James W. Wood, Ph.D. (U. Michigan) *Professor of Anthropology*

The master's program is designed to train students in general anthropology. The doctoral program is structured to train students in the following areas of specialization: ethnology (with subspecialization in social anthropology, demographic anthropology, cultural evolution, and ecology); archaeology (with subspecialization in cultural ecology, analytical approaches, technological methods, and culture areas); biological anthropology (with subspecialization in human adaptability, genetics, biological demography, human evolution, and the behavioral biology of human and non-human primates).

Admission Requirements

Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Undergraduate preparation must include 12 credits in anthropology and archaeology or their equivalent. A student with an excellent record but who does not meet these requirements may be admitted provided course deficiencies are made up without graduate credit. Students with a 3.00 or higher junior/senior average (on a 4.00 scale) and with appropriate course backgrounds who have research interests directly related to the special anthropological competencies within the department will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

Master's Degree Requirements

M.A. candidates may submit either a thesis or a term paper. If the latter is chosen, 6 credits in 500-level courses in the major field must be scheduled in lieu of thesis credits. The M.A. degree may be bypassed by exceptional candidates for the Ph.D. degree.

Doctoral Degree Requirements

The communication and foreign language requirement for the Ph.D. degree includes a reading knowledge of a foreign language plus an option from among additional foreign languages, field languages, linguistics, or statistics.

Student Aid

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AID section of the *Graduate Bulletin*, the following award typically has been available to post-comprehensive graduate students in this program:

HILL FELLOWSHIPS FOR STUDY IN ANTHROPOLOGY—Details available from Professor Dean R. Snow, Department of Anthropology, 409 Carpenter Building.

ANTHROPOLOGY (ANTH)

- 401. HUMAN EVOLUTION: THE MATERIAL EVIDENCE (3)
- 405. PRIMATOLOGY (3)
- 406W. PROBLEMS IN HUMAN EVOLUTION (3)
- 408. ANTHROPOLOGICAL DEMOGRAPHY (3)
- 409. QUANTITATIVE ANALYSIS OF ANTHROPOLOGICAL DATA (2)
- 410. OSTEOLOGY LABORATORY (1)
- 420. ARCHAEOLOGY OF THE NEAR EAST (3)
- 422. MESOAMERICAN ARCHAEOLOGY AND ETHNOGRAPHY (3)
- 423. THE EVOLUTION OF AMERICAN INDIAN CULTURE (3)
- 425. PEOPLE, CULTURE, AND THE ENVIRONMENT IN THE AMERICAN SOUTHWEST (3)
- 440. SOUTH AMERICAN TRIBAL SOCIETIES (3)
- 450. COMPARATIVE SOCIAL ORGANIZATION (3)
- 451. ECONOMIC ANTHROPOLOGY (3)
- 453. ANTHROPOLOGY OF RELIGION (3)
- 454. POLITICAL ANTHROPOLOGY (3)
- 456. CULTURAL ECOLOGY (3)
- 457. LANGUAGE IN CULTURE (3)
- 460. (BIOL) HUMAN GENETICS (3)
- 464. (BIOL) SOCIOBIOLOGY (3)
- 471. HUMAN EVOLUTIONARY BIOLOGY I (3)
- 472. HUMAN EVOLUTIONARY BIOLOGY II (3)
- 473. GENETICS OF HUMAN DISEASE (3)
- 474. ECOLOGY OF GENDER (3)
- 475. THE BIOMETRY OF HUMAN REPRODUCTION (3)
- 476. (WMNST) ANTHROPOLOGY OF GENDER (3)
- 488. ARCHAEOLOGICAL METHODS AND THEORY (3)
- 492. INTERMEDIATE FIELD METHODS (3–6)
- 493. FIELD TECHNIQUES (3–6)
- 495. INTERNSHIP IN MEDICAL ANTHROPOLOGY (6–9)
- 496. INDEPENDENT STUDIES (1–18)
- 497, 498. SPECIAL TOPICS (1–9)
- 499. FOREIGN STUDIES—ANTHROPOLOGY (1–12)

- 501. HUMAN EVOLUTION: THE MATERIAL EVIDENCE (4) Human origins as seen in the fossil record and comparative biology of humans and their primate relatives.
- 508. RESEARCH PROBLEMS IN CULTURAL HISTORY (3–9)
- 509. RESEARCH DESIGN IN ANTHROPOLOGICAL FIELDWORK (3) A survey of research design, sampling strategies, potential biases, confounding problems, and the limits of inference in anthropological fieldwork. Prerequisite: STAT 451.
- 511. (HL ED) HEALTH IMPLICATIONS IN THE GROWTH AND DEVELOPMENT OF SCHOOL CHILDREN (3) Child growth and development emphasis for teachers; medical inspection and examination; preschool program; early habit formations; behavior problems.
- 513. (HL ED) HEALTH IMPLICATIONS IN MATURITY AND AGING (3) Changes in the human body in maturity and aging; mechanisms of physiologic aging; implications for health and preventive medicine. Prerequisite: ANTH (HL ED) 511.
- 515. ETHNOGRAPHIC METHODS (3) Analysis of ethnographic methods used in studying different cultures.
- 522–523. ECOLOGICAL THEORY IN ANTHROPOLOGY (3 each) Human biology, culture history, and culture variation from the ecological perspective. Two-semester enrollment required. Prerequisite: 6 credits in anthropology.

530. INDIVIDUAL READINGS IN ANTHROPOLOGY (1–6) Reading or research in selected aspects of general anthropology.
531. INDIVIDUAL RESEARCH IN ANTHROPOLOGY (3–12)
545. SEMINAR IN ANTHROPOLOGY (1–9) Critical analysis of research in selected areas of anthropology.
556. SOCIAL ORGANIZATION OF TRADITIONAL SOCIETIES (3) Cultural bases of social organization of traditional societies.
557. BEHAVIORAL ANTHROPOLOGY I: COGNITION (3) Cognitive anthropology, emphasizing kinship systems, cultural categories, and anthropological linguistics.
559. BEHAVIORAL ANTHROPOLOGY III: ECOLOGY (3) Ecological anthropology, emphasizing the adaptive aspects of subsistence, including foraging and settlement pattern.
560. HISTORY OF ANTHROPOLOGICAL THEORY (3) Survey of origin and development of anthropology in the nineteenth century and trends during the twentieth century. Prerequisite: ANTH 450.
561. FIELD METHODS IN ANTHROPOLOGY (3–9) Individual fieldwork in any aspect of anthropology, supervised by staff of professional rank.
562. LABORATORY METHODS IN ANTHROPOLOGY (3–9) Supervised laboratory research, utilizing materials from physical anthropology, archaeology, or cultural anthropology.
564. TOPICS IN SOCIOBIOLOGY AND BEHAVIORAL ECOLOGY (3–6) Critical analysis of specialized topics in sociobiology and behavioral ecology. Prerequisite: an introductory course in anthropology or biology.
565. (WMNST) WOMEN AND DEVELOPMENT (3) Interaction of women and development.
571. PRINCIPLES OF HUMAN POPULATION BIOLOGY I (3) Mechanisms and quantification of human genetic variation and survey of evolutionary aspects of human ecology, life cycle, and population biology.
572. PRINCIPLES OF HUMAN POPULATION BIOLOGY II (3) How human genetic variation is detected, the assessment of human quantitative genetic traits, and application to the human fossil record.
573. GENETICAL EPIDEMIOLOGY (3) Epidemiological and genetic approaches to understanding patterns of difference in disease susceptibility and their evolution in human populations. Prerequisites: ANTH 460 or BIOL 428; STAT 250 or 301.
588. METHOD AND THEORY IN ARCHAEOLOGY (4) Methodological strategies and tactics in archaeological research; major theories in cultural anthropology as applied to archaeological data.
590. COLLOQUIUM (1–3)
593. (BIOL, ENT, GEOSC, INTAG) TROPICAL FIELD STUDIES (Organization for Tropical Studies) (8) An intensive field course concentrating on field problems, experimental design, and data analysis in tropical habitats. Prerequisite: approval by the Committee on Tropical Studies.
596. INDIVIDUAL STUDIES (1–9)
597. SPECIAL TOPICS (1–9)

APPLIED PSYCHOLOGY (PSYC)

BARBARA A. BREMER, *Coordinator*

Penn State Harrisburg
 Middletown, PA 17057
 717-948-6063

Degree Conferred: M.A.

The Graduate Faculty

John Steven Backels, Ph.D. (Ball State) *Affiliate Assistant Professor of Psychology*
 Michael A. Becker, Ph.D. (SUNY, Albany) *Associate Professor of Psychology*
 Jacqueline Bichsel, Ph.D. (Alabama) *Assistant Professor of Psychology*
 Thomas G. Bowers, Ph.D. (Virginia Polytechnic) *Associate Professor of Psychology*
 Barbara A. Bremer, Ph.D. (Bryn Mawr) *Associate Professor of Psychology*
 Richard M. Foxx, Ph.D. (Illinois) *Professor of Psychology*
 Marsali Hansen, Ph.D. (Vanderbilt) *Assistant Professor of Behavioral Science*
 Helen M. Hendy, Ph.D. (California, Riverside) *Assistant Professor of Psychology*
 Rita M. Shell, Ph.D. (Arizona State) *Assistant Professor of Psychology*

The aim of the program, offered at Penn State Harrisburg, is to train and educate students to provide applied services as mental health professionals. Graduates of the program work under the supervision of independent practitioners or in agency settings. Training will focus on : providing clinical/behavioral services to individuals, families, and groups; developing, administering, and interpreting evaluation methods; understanding the principles of behavioral assessment; and developing and promoting prevention and health programs. Content areas will include psychopathology, addictions, health and health behaviors, prevention, and developmental psychopathology. Practicum experiences will be required to allow for supervised applications of the training and academic experiences.

The Applied Psychology program will be concerned with providing students with the fundamentals of theory, practice, and research within the areas of psychopathology, treatment, prevention, and health. The program will provide 22 credits of skill-based education, with 15 credits of research education.

Admission Requirements

Students will be admitted on a competitive basis, based on the following criteria: (1) a completed bachelor's degree from a regionally accredited academic institution, with at least 18 credits in psychology, with a cumulative grade-point average (GPA) of 3.00 or above in the last 60 credits; (2) undergraduate course work must include a statistics course and a psychology research methods course with grades of B or above; (3) scores from the Graduate Record Examination (GRE) are required in the verbal, quantitative, and analytic portions; (4) three letters of recommendation; and (5) a brief (two-page) interest statement.

Degree Requirements

Requirement for the M.A. in Applied Psychology include 37 credits in required courses including the master's project and 3 credits in electives, for a total of 40 credits. With the consent of the student's faculty adviser, up to 3 graduate-level credits from other programs may be used as electives.

APPLIED PSYCHOLOGY (PSYC)

- 400. HEALTH PSYCHOLOGY (3)
- 403. ADULT DEVELOPMENT (3)
- 405. DEVELOPMENTAL PSYCHOLOGY (3)
- 406. ADOLESCENCE (3)
- 409. CHILD BEHAVIOR DISORDERS (3)
- 410. PSYCHOLOGY OF THE DIFFERENTLY ABLED (3)
- 412. HISTORY AND SYSTEMS OF PSYCHOLOGY (3)
- 415. ABNORMAL PSYCHOLOGY (3)
- 421. BEHAVIOR MODIFICATION (3)
- 424. PHYSIOLOGICAL PSYCHOLOGY (3)
- 425. COGNITION AND PERCEPTION (3)
- 427. LEARNING THEORY (3)
- 444. TREATMENT AND EDUCATION IN DEVELOPMENTAL DISABILITIES (3)
- 450. STATISTICS AND RESEARCH DESIGN I (4)
- 451W. STATISTICS AND RESEARCH DESIGN II (4)
- 465. PSYCHOLOGY OF WOMEN (3)
- 470. STATISTICAL ANALYSIS WITH SPSS (3)
- 482. PERSONALITY THEORY (3)
- 492. CURRENT TOPICS IN PSYCHOLOGY (3)
- 494. RESEARCH PROJECT (1-12)
- 496. INDEPENDENT STUDIES (1-18)
- 497, 498. SPECIAL TOPICS (1-9)

- 502. APPLIED SOCIAL PSYCHOLOGY (3) An examination of social psychological applications to areas such as health, law, interpersonal relations, environment, politics, and other social issues.
- 511. PSYCHOPATHOLOGY (3) A broad spectrum view of psychopathology including biological, social, cognitive, psychological, and neuropsychological approaches, is emphasized, with an applied focus. Prerequisite: admission to program.
- 512. THEORIES AND MODELS OF PSYCHOTHERAPY (3) An advanced level of psychotherapies and applications in diverse settings. Prerequisite: PSYC 511, admission to the program.

514. PREVENTIVE PSYCHOLOGY (3) Focuses on the theoretical, conceptual, programmatic, and empirical issues currently in preventive psychology. Prerequisite: PSYC 520.
515. CLINICAL HEALTH PSYCHOLOGY (3) Examines wellness maintenance, early detection, and the impact of health care on individuals and the community. Prerequisite: admission to program.
520. RESEARCH METHODS (3) Prerequisites: SCLSC 470 and admission to program.
530. RESEARCH PAPER (3) Supervised research in psychology for degree candidates. Prerequisites: PSYC 520, SCLSC 470, and permission of the program.
535. BEHAVIORAL MANAGEMENT (3) Analysis of determinants of behavior and behavioral ecology. Emphasis on data collection and data evaluation techniques.
571. TESTS AND MEASUREMENT (4) Administration, analysis, and interpretation of psychological evaluation methods will be reviewed. Prerequisite: SCLSC 470 and admission to program.
572. NEUROPSYCHOLOGICAL ASSESSMENT (3) Course will review the biological bases of behavior, emphasizing brain-behavioral relationships and assessment of these relationships. Prerequisite: PSYC 571.
595. INTERNSHIP (1–18)
596. INDIVIDUAL STUDIES (1–9)
597. SPECIAL TOPICS (1–9)

ARCHITECTURAL ENGINEERING (A E)

RICHARD G. MISTRICK, *Graduate Program Officer*
104 Engineering A Building
814-863-2086

Degree Conferred: Ph.D., M.S., M.A.E., M.Eng.

The Graduate Faculty

William P. Bahnfleth, Ph.D. (Illinois) *Assistant Professor of Architectural Engineering*
Richard A. Behr, Ph.D. (Texas Tech) *Head; Professor of Architectural Engineering*
Craig A. Bernecker, Ph.D. (Penn State) *Associate Professor of Architectural Engineering*
Thomas E. Boothby, Ph.D. (Washington) *Associate Professor of Architectural Engineering*
Hossam El-Bibany, Ph.D. (Stanford) *Assistant Professor of Architectural Engineering*
Eric F. P. Burnett, Ph.D. (Imperial College, London) *Professor of Architectural and Civil Engineering*
Louis F. Geschwindner, Ph.D. (Penn State) *Professor of Architectural Engineering*
Linda M. Hanagan, Ph.D. (Virginia Tech) *Assistant Professor of Architectural Engineering*
Ali. M. Memari, Ph.D. (Penn State) *Assistant Professor of Architectural Engineering*
Richard G. Mistrick, Ph.D. (Penn State) *Associate Professor of Architectural Engineering*
Stanley A. Mumma, Ph.D. (Illinois) *Professor of Architectural Engineering*
Amr A. Oloufa, Ph.D. (Berkeley) *Assistant Professor of Architectural Engineering*
M. Kevin Parfitt, M.Eng. (Cornell) *Associate Professor of Architectural Engineering*
Victor E. Sanvido, Ph.D. (Stanford) *Professor of Architectural Engineering*

Students may specialize in building construction, building illumination systems, building mechanical and energy systems, or building structural systems.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are required for admission to the Ph.D. and M.S. programs. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Graduate students in Architectural Engineering generally come into their program of study with an undergraduate degree in mechanical engineering, electrical engineering, civil engineering, architectural engineering, or architecture. Students with a 3.00 junior/senior grade-point average (on a 4.00 scale) and with appropriate course backgrounds will be considered for admission to the Ph.D. and M.S. programs. Students with a 2.75 average will be considered for admission to the M.Eng. program. All degree candidates are required to provide a letter of intent outlining the student's intended area of study as well as three letters of recommendation. The best-qualified applicants will be accepted up to the number of spaces that are available for new students.

A limited number of undergraduate students in the BAE program will be considered for admission to the integrated undergraduate/graduate program leading to the B.A.E. and the M.A.E. degrees. Students who are currently enrolled in the seventh semester of the B.A.E. degree program may be admitted to the integrated BAE/MAE program, following a positive review of an application specific to this program, by the faculty committee on graduate admissions. Students must have maintained a GPA for classes taken in the third and fourth years of at least 3.00 and must have attained a grade of C or better in all classes listed as A E. Students admitted to the integrated program must maintain a GPA of at least 3.00 in classes used toward the M.A.E. degree.

Degree Requirements

Continuous registration is required for all M.S. and Ph.D. graduate students until the thesis is approved. A thesis is required for the M.S. degree. Candidates for the M.Eng. degree are required to complete 30 credits of course work. Each candidate for the Ph.D. degree must satisfy the associated research and communication skills requirements established by the department.

For the integrated B.A.E./M.A.E. degree, 30 credits of course work are required. Of the credits taken toward the B.A.E., 12 credits may be counted toward both the undergraduate and graduate degrees.

Student Aid

Graduate assistantships and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*. A limited number of research and teaching assistantships, scholarships, and fellowships are available to M.S. and Ph.D. students in the Department of Architectural Engineering. The intent of these assistantships and awards is to support students conducting research under faculty supervision. For this reason, students in the M.S. and Ph.D. programs who receive these types of financial support are expected to complete their degree program, including the thesis or dissertation, and may not transfer to the Master of Engineering program.

ARCHITECTURAL ENGINEERING (A E)

- 401. STRUCTURAL DESIGN OF BUILDINGS (3)
- 402. STRUCTURAL DESIGN OF BUILDINGS (3)
- 403. STRUCTURAL DESIGN OF BUILDINGS (3)
- 421. ARCHITECTURAL STRUCTURAL SYSTEMS I (3)
- 422. ARCHITECTURAL STRUCTURAL SYSTEMS II (3)
- 423. ARCHITECTURAL STRUCTURAL SYSTEMS III (3)
- 424. ENVIRONMENTAL CONTROL SYSTEMS I (3)
- 425. ENVIRONMENTAL CONTROL SYSTEMS II (3)
- 430. INDETERMINATE STRUCTURES (3)
- 431. STRUCTURAL DESIGN OF BUILDINGS (3)
- 439. MODERN STRUCTURAL SYSTEMS (3)
- 454. ADVANCED HEATING, VENTILATING, AND AIR CONDITIONING (3)
- 455. ADVANCED HEATING, VENTILATING, AND AIR CONDITIONING SYSTEM DESIGN (3)
- 456. SOLAR ENERGY BUILDING SYSTEM DESIGN (3)
- 458. ADVANCED ARCHITECTURAL ACOUSTICS AND NOISE CONTROL (3)
- 461. BASIC THEORY OF BUILDING ILLUMINATION (3)
- 464. ADVANCED ARCHITECTURAL ILLUMINATION SYSTEMS DESIGN (3)
- 466. COMPUTER-AIDED LIGHTING DESIGN AND ANALYSIS (3)
- 467. ADVANCED BUILDING ELECTRICAL SYSTEM DESIGN (3)
- 470. RESIDENTIAL BUILDING DESIGN AND CONSTRUCTION (3)
- 471. BUILDING-CONSTRUCTION ASSEMBLIES (3)
- 472. BUILDING-CONSTRUCTION MANAGEMENT (3)
- 473. BUILDING-CONSTRUCTION MANAGEMENT (3)
- 474. BUILDING-CONSTRUCTION ESTIMATING (3)
- 475. BUILDING-CONSTRUCTION ENGINEERING I (3)
- 476. BUILDING-CONSTRUCTION ENGINEERING II (3)
- 486. PROFESSIONAL ENGINEERING PRACTICE (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497, 498. SPECIAL TOPICS (1-9)

520. ROOM AND BUILDING ACOUSTICS (4) Sound propagation in enclosures. Transmission through partitions. Design of spaces for optimum listening and industrial buildings for low noise. Prerequisites: A E 458, ACS 402.

532. CONCRETE STRUCTURES REINFORCED WITH FIBER REINFORCED PLASTICS (3) Physico-chemical, mechanical behavior of fiber-reinforced plastics (FRP); manufacturing of FRP; performance, analysis, and design of FRP reinforced concrete structures. Prerequisite: A E 402.
535. DESIGN AND THEORY OF MASONRY STRUCTURES (3) Analysis and design of unreinforced and reinforced masonry structures: masonry properties, beams, walls, pilasters, shear walls, arches, and systems. Prerequisites: A E 402 or C E 441; A E 308 or C E 240.
540. CONSTRUCTION PROJECT ORGANIZATION AND CONTROL (3) Applications of productivity improvement; organizational; behavioral; and modeling techniques to solve construction project problems; case studies; development of audit manual. Prerequisites: A E 372, 475, or 476.
541. COMPUTER INTEGRATED CONSTRUCTION (3) Design/development of information systems to support facility management, design construction, operations; information architectures, product/process models, advanced computer tools. Prerequisite: A E 540.
545. ARCHITECTURAL ENGINEERING SEMINAR (1-6) Current literature and special problems in architectural engineering; presentation of technical papers.
552. AIR QUALITY IN BUILDINGS (3) Indoor air pollutants, their sources and health effects; transport of pollutants; modeling of pollutant concentration in buildings. Prerequisites: A E 454, 455, M E 412.
553. BUILDING ENERGY ANALYSIS (3) Fundamentals of building energy dynamics and the simulation of energy flows in a building; validation of programs; practical applications. Prerequisites: A E 454, 455, M E 412.
554. BUILDING THERMAL SYSTEMS DESIGN AND OPTIMIZATION (3) A study of building thermal comfort systems emphasizing analytical peak and off-peak design performance modeling, simulation, optimization, and economics. Prerequisite: A E 454.
555. BUILDING AUTOMATION AND CONTROL SYSTEMS (3) Advanced techniques in the theoretical analysis and practical design of the automatic comfort controls used in building thermal systems. Prerequisite: A E 554.
556. SOLAR ENGINEERING OF THERMAL PROCESSES (3) Advanced quantitative methods of predicting transient active and passive solar process performance with an emphasis on building solar applications. Prerequisite: M E 412.
562. LUMINOUS FLUX TRANSFER (3) Radiative transfer applied to lighting analysis; methods for computing direct and interreflected illumination; nearfield photometry. Prerequisites: A E 461; CMPSC 201 or 201F.
565. DAYLIGHTING (3) Daylight concepts, solar position, sky luminance distribution models, integration of daylighting and electric lighting controls, physical modeling, computer analysis techniques. Prerequisite: A E 461.
590. COLLOQUIUM (1-3)
594. RESEARCH TOPICS (1-18)
594. RESEARCH TOPICS (1-18)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

ARCHITECTURE (ARCH)

JAWAID HAIDER, *Interim Head and Professor In Charge of Graduate Program in Architecture*
206 Engineering Unit C
814-865-9535

Degree Conferred: M.S.

The Graduate Faculty

Arthur K. Anderson, Jr., M.F.A. (Princeton) *Associate Professor of Architecture*
Pier Luigi Bandini, Lau.Arch. (U. of Florence, Italy) *Associate Professor of Architecture*
Sidney Cohn, Ph.D. (North Carolina, Chapel Hill) *Professor Emeritus of Urban Design*
Gideon Golany, Ph.D. (Hebrew, Jerusalem) *Distinguished Professor of Urban Design*
Jawaid Haider, Ph.D. (Penn State) *Professor of Architecture*
Louis Inserra, M.Arch. (Yale) *Professor of Architecture*
Loukas Kalisperis, Ph.D. (Penn State) *Associate Professor of Architecture*
James Kalsbeek, M.S. Arch. (Cincinnati) *Associate Professor of Architecture*
Donald E. Kunze, Jr., Ph.D. (Penn State) *Associate Professor of Architecture and Integrative Arts*
Don A. Leon, M.S.Arch. (Penn State) *Associate Professor of Architecture*

John P. Lucas, M.Arch. (North Carolina State) *Professor of Architecture*

Romolo Martemucci, M.S.Urb.Des. (Pratt Institute) *Associate Professor of Architecture*

Raymon J. Masters, M.S.Arch.Eng. (Penn State) *Affiliate Associate Professor of Architecture*

Wladyslaw A. Strumillo, Ph.D. (Polytechnic, Warsaw) *Associate Professor Emeritus of Architecture*

Daniel Willis, M.S.Arch. (Penn State) *Associate Professor of Architecture*

The Master of Science is an academic degree; it is not a professionally accredited degree. It is intended for students with professional degrees in architecture and, in exceptional cases, for students with non-professional architectural degrees who seek to develop a better understanding of the principles and theory that underlie the profession of architecture. The program emphasizes the application of theory and inquiry to architectural and urban design. Advanced study is offered in selected areas defined by faculty expertise such as: architectural theory; computer application and representation; design/planning methods; urban design; environment-behavior theory; and the design of public spaces. The program is small and flexible and offers the opportunity to pursue individual goals, independent inquiry and research, and interdisciplinary study.

Admission Requirements

Scores from the Graduate Record Examination (GRE) or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School are required for admission. At the discretion of the graduate faculty, a student may be admitted provisionally for graduate study in a program without these scores. The GRE testing program will change significantly in 1997. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

The Graduate School establishes specific requirements regarding the TOEFL exam for international students. In addition to those requirements, the Department of Architecture requires that international students whose first language is not English or who have not received baccalaureate or master's degrees from an institution in which the language of instruction is English must take the TOEFL (Test of English as a Foreign Language) and the Test of Spoken English (TSE). A score on the TOEFL of 580 or higher and on the TSE of 250 or higher is required for regular admission. Applicants with scores on the TOEFL below 580 but above 550 or on the TSE below 250 but higher than 215 may be admitted provisionally.

Students with a 3.00 junior/senior grade-point average (on a 4.00 scale) and with appropriate course backgrounds will be considered for admission. Exceptions to the minimum 3.00 average may be made for students with special backgrounds, abilities, and interests.

All applicants must submit (1) a minimum of three statements of recommendation from faculty members acquainted with the applicant's academic history and/or recommendations by an undergraduate review committee; (2) a paper of no more than 500 words, consisting primarily of a description of the applicant's professional goals, his or her desired areas or subjects of study, and the area(s) of anticipated research or inquiry; and (3) a portfolio of design work (architecture and planning projects) executed at the undergraduate level or under professional guidance, or independently, provided that such work can be evidenced as executed by the applicant. A minimum portfolio representation of one project for each year of academic undergraduate study, or its equivalent, is required.

The best-qualified applicants will be accepted up to the number of spaces that are available for new students.

Degree Requirements

A total of 30 credits, including a thesis, are required for the Master of Science degree. The thesis may include a design project component. The required course work includes: a required core of 14 credits consisting of research studio (6 credits), theory (3 credits), methods of research and inquiry (3 credits), and Colloquium (2 credits); a concentration area (6 credits); electives (4 credits); and thesis (6 credits).

Student Aid

Graduate assistantships and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*. All applicants who are accepted are considered for departmental financial aid.

ARCHITECTURE (ARCH)

451. ARCHITECTURAL PROFESSIONAL PRACTICE (3)

480. TECHNICAL SYSTEMS INTEGRATION (3)

481. ADVANCED ARCHITECTURAL DATA SYSTEMS I (3)

482. ADVANCED ARCHITECTURAL DATA SYSTEMS II (3)

- 491. ARCHITECTURE DESIGN—THESIS I (6)
- 492. ARCHITECTURE DESIGN—THESIS II (6)
- 496. INDEPENDENT STUDIES (1–18)
- 497. SPECIAL TOPICS (1–9)

- 511. THEORETICAL PERSPECTIVES IN ARCHITECTURE (3) The impact of rationalism and romanticism on contemporary developments and theoretical postures in architectural design.
- 514. APPLYING ENVIRONMENT-BEHAVIOR RESEARCH TO ARCHITECTURE AND URBAN DESIGN (3) Application of environment-behavior research to the design and evaluation of architectural and urban settings. Prerequisite: 6 credits in psychology, sociology, or related behavioral science courses.
- 520. METHODS OF INQUIRY IN ARCHITECTURE AND URBAN DESIGN (3) Introduction to the methods of research and inquiry commonly used in architecture and urban design.
- 522. COMPUTATION METHODS IN ARCHITECTURAL DESIGN (3) Inquiry into the process of integrating computers in architectural design based on science, rationality, and language paradigms in architectural computing.
- 536. DESIGN INQUIRY (1–12) Integration of research with the designing of architectural and urban settings.
- 590. COLLOQUIUM (1–3)
- 591. ARCHITECTURAL RESEARCH (2–12) Guided research project.
- 596. INDIVIDUAL STUDIES (1–9)
- 597. SPECIAL TOPICS (1–9)

Integrated B.Arch.–M.S.Arch. Program

The Department of Architecture offers a limited number of academically superior students enrolled in the fourth year of the program leading to a Bachelor of Architecture degree the opportunity to enroll in an integrated program leading to both the B.Arch. and the Master of Science in Architecture degrees. The program permits the student to integrate the fifth year of study for the professional B.Arch. degree with the program of study for the M.S.Arch. degree into a continuous program of study culminating in both degrees. The ability to coordinate as well as concurrently pursue the two degree programs enables the student to achieve greater depth and comprehensiveness than if the degrees are pursued sequentially and to earn the two degrees in a shorter period. In particular, the program encourages the student to integrate the undergraduate thesis design project with the master's thesis, thereby achieving a greater depth of inquiry.

The number of openings to this special program is limited; admission is by invitation of the faculty and is extremely selective.

Admission Requirements

Applicants to the integrated program must be enrolled in the fourth year of a B.Arch. program or otherwise qualified to apply for admission to the fifth year of the B.Arch. program at Penn State. To be admitted, applicants must be able to meet the following requirements:

- Must have completed a B.S.Arch., or other degree qualifying for admission to the B.Arch. program, prior to entry into the Integrated Degree program.
- Must be unconditionally accepted into the fifth year of the B.Arch. program at Penn State.
- Must be unprovisionally accepted into the M.S.Arch. program at Penn State (see application requirements for the M.S.Arch. degree in the Penn State Graduate Degree Programs Bulletin).
- Must have a minimum 3.20 junior/senior overall grade-point average (on a 4.0 scale) as well as: (1) a minimum 3.20 GPA in architectural design courses (studio), and (2) a minimum 3.20 GPA in all course work except architectural design courses (studio).
- In addition to the normal application requirements for the M.S.Arch. degree, the student applicant shall provide a Plan of Study of not more than 1,500 words. The plan shall clearly describe the student's proposed general thesis topic and a strategy for pursuing it, including a list of proposed courses and a list of faculty whom the student foresees as contributing to the course of study.

The best-qualified students will be accepted up to the number of spaces available for new students. Acceptance to the program prior to the completion of all required course work is provisional, contingent upon meeting the previous requirements.

ART (ART)

THOMAS F. MCGOVERN III, *In Charge of Graduate Programs in Art*
210 Patterson Building
814-865-0444

Degrees Conferred: M.A., M.F.A.

The Graduate Faculty

Micaela Amato, M.F.A. (Colorado) *Associate Professor of Art and Women's Studies*
Charles S. Cave, B.F.A. (Miami University, Ohio) *Associate Professor of Art*
Paul Chidester, M.F.A. (Art Institute, Chicago) *Assistant Professor of Art*
John A. Cook, M.F.A. (Iowa) *Professor Emeritus of Art*
David R. DonTigny, M.A. (Montana) *Professor Emeritus of Art*
Robin L. Gibson, M.F.A. (Wisconsin) *Associate Professor of Art*
Kenneth R. Graves, M.F.A. (San Francisco Art Institute) *Professor of Art*
Grace Hampton, Ph.D. (Arizona State) *Professor of Art and Art Education*
Marc Hessel, M.F.A. (Iowa) *Associate Professor of Art*
James Hopfensperger, M.A. (Illinois), M.F.A. (Michigan) *Associate Professor of Art*
John D. Kissick, M.F.A. (Cornell) *Associate Professor of Art*
Gerald Lang, M.F.A. (Minnesota) *Professor of Art*
Leslie Leupp, M.F.A. (Indiana) *Professor of Art*
Jerrold Maddox, M.F.A. (Indiana) *Professor of Art*
Richard Mayhew *Professor Emeritus of Art*
Sallie McCorkle, M.F.A. (Rutgers) *Associate Professor of Art*
Thomas McGovern, M.F.A. (Tyler School of Art) *Associate Professor of Art*
William J. McHale, D.Ed. (Penn State) *Associate Professor Emeritus of Art*
Helen O'Leary, M.F.A. (Art Institute, Chicago) *Assistant Professor of Art*
Stephen Porter, M.F.A. (Cornell) *Professor of Art*
Elizabeth Quakenbush, M.F.A. (Rochester Inst of Technology) *Assistant Professor of Art*
Jean Sanders, M.F.A. (Wisconsin, Madison) *Associate Professor of Art*
Bruce R. Shobaken, M.F.A. (Minnesota) *Professor Emeritus of Art*
Kristin Sommese, M.F.A. (Tyler School of Art) *Associate Professor of Art*
Lanny B. Sommese, M.F.A. (Illinois) *Professor of Art*
Christopher P. Staley, M.F.A. (Alfred) *Associate Professor of Art*
James E. Stephenson, Jr., M.A. (Montana) *Professor of Art*
Robert Yarber, M.F.A. (Louisiana State) *Assistant Professor of Art*

The M.A. program is planned to provide a broad range of experience and study in the visual arts. The M.F.A. program is planned to provide professional emphasis in a specific area of art.

Admission Requirements

Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Requirements for admission to the M.A. program include a broad undergraduate training in art and the presentation of a portfolio of the applicant's work.

The Master of Fine Arts program in art, with its emphasis on professional study, is designed for the mature individual who by previous training and study has sufficiently prepared for the undertaking. It is strongly suggested that applicants have a minimum of 12 credits of art history at the undergraduate level. Any qualified student who has graduated from an accredited college that offers a bachelor of arts, bachelor of science, or bachelor of fine arts in the area of art of the equivalent may seek admission. The School of Visual Arts requires a minimum of 3.00 junior/senior grade-point average (on a 4.00 scale) for admission to the master of fine arts program. Exceptions to the minimum 3.00 average may be made for students with special backgrounds, abilities, and interests.

In addition to the previous requirements, all applicants must submit:

(1) **A portfolio** of his/her work to illustrate his/her preparation for graduate study. A portfolio of slides, rather than actual work, is preferred. A selection of no newer than twenty examples should be presented. The majority should be in the area of the applicant's interest.

(2) **A statement** of professional aims. This statement should include the applicant's intentions for his/her proposed study. Some indications of his/her philosophy, beliefs, and goals in regard to education and

art should give evidence that he/she is prepared to undertake the work outlined for the Master of Fine Arts program.

(3) **Three letters of reference** attesting to the applicant's scholarship and ability to work independently.

Degree Requirements

A thesis in an area of specialization is required for the M.A. degree.

The School of Visual Arts requires a minimum total of 60 credits for the Master of Fine Arts degree. Not more than 10 credits may be transferred from other accredited graduate institutions. Of the 60 credits required for graduation, candidates are expected to complete the following distribution of credits: 30 credits in a major area of concentration, 12 credits in art history and critical studies, 10 credits in related areas, and 8 credits in graduate seminar.

ADDITIONAL M.F.A. REQUIREMENTS: For M.F.A. candidates, at least 24 credits of the required 60 credits must be at the 500 level. In addition to course work, M.F.A. candidates must pass a candidacy review, which is usually held at the end of the second semester of study, submit an artist's statement, pass the M.F.A. comprehensive oral examination and produce an M.F.A. exhibition.

Student Aid

Graduate assistantships and other forms of student aid are described in the **STUDENT AID** section of the *Graduate Bulletin*.

ART (ART)

- 401. WOMEN ARTISTS IN THE TWENTIETH CENTURY (3)
- 411. SEMINAR IN CONTEMPORARY ART (3 per semester, maximum of 6)
- 417. ADVANCED METAL ARTS (4 per semester, maximum of 12)
- 421. DRAWING (4 per semester, maximum of 12)
- 422. ADVANCED FIGURE DRAWING (4 per semester, maximum of 8)
- 430. ADVANCED SCULPTURE (4 per semester, maximum of 12)
- 431. INSTALLATION ART (4)
- 440. ADVANCED PRINTMAKING (4 per semester, maximum of 12)
- 445. HANDMADE PAPERMAKING (4 per semester, maximum of 12)
- 446. ARTISTS BOOKS (4)
- 450. ADVANCED PAINTING (4 per semester, maximum of 12)
- 455. ADVANCED PAINTING CRITIQUE (4 per semester, maximum of 8)
- 460. ADVANCED WATER-BASED MEDIA (4 per semester, maximum of 8)
- 470. TIME AND SEQUENCE (4)
- 471. SENIOR PROBLEMS (4)
- 473. GRAPHIC DESIGN SEMINAR A (3)
- 474. GRAPHIC DESIGN AND THE COMPUTER (4)
- 480. ADVANCED CERAMIC ARTS (4 per semester, maximum of 12)
- 481. CERAMIC MATERIALS AND GLAZE CALCULATION (3)
- 491. PHOTOGRAPHY AND OTHER DISCIPLINES (4 per semester, maximum of 12)
- 492. CREATIVE PROJECTS IN PHOTOGRAPHY (4 per semester, maximum of 8)
- 493. PHOTOGRAPHY: PORTFOLIO PREPARATION (1)
- 494. PHOTO ASSEMBLAGE (4 per semester, maximum of 8)
- 495. INTERNSHIP (1-18)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
- 499. FOREIGN STUDIES—ART (1-12)

501. ART RESEARCH (2-6) Original study and practice in art relating to material, concept, or technique.

517. METAL ARTS (2-12) Individual problems in metal arts leading to a focus and development of a body of work representative of the artist.

530. ADVANCED SCULPTURE (3-12) Individual projects in sculpture leading to the development of a collection or body of work representative of the artist.

545. PRINTMAKING (2-12) Problems in printmaking leading to the development of a collection or body of work representative of the individual artist.

550. PAINTING (2-12) Individual problems in painting leading to the development of a collection or body of work representative of the artist.

570. DESIGN (2–12) Individual projects in design, with special emphasis on professional practice in specialized fields of graphic design.
580. CERAMICS (2–12) Experimental problems in ceramics leading to the development of a collection or body of work representative of the individual.
592. PHOTOGRAPHY (2–12) Individual projects in photography leading to the development of specialized work representative of the artist. Prerequisites: 12 credits in ART 492.
596. INDIVIDUAL STUDIES (1–9)

ART EDUCATION (A ED)

BRENT G. WILSON, *In Charge of Graduate Programs in Art Education*
207 Arts Cottage
814-865-6570

Degrees Conferred: Ph.D., D.Ed., M.S., M.Ed.

The Graduate Faculty

Patricia Amburgy, Ph.D. (Illinois) *Associate Professor of Art Education*
Albert A. Anderson, Ph.D. (Ohio State) *Associate Professor of Art Education*
Kenneth R. Beittel, D.Ed. (Penn State) *Professor Emeritus of Art Education*
Paul Bolin, Ph.D. (Oregon) *Associate Professor of Art Education*
Charles R. Garoian, Ph.D. (Stanford) *Associate Professor of Art Education*
Yvonne M. Gaudelius, Ph.D. (Penn State) *Assistant Professor of Art Education and Women's Studies*
Jane Gooding-Brown, Ph.D. (Ohio State) *Assistant Professor of Art Education*
Grace Hampton, Ph.D. (Arizona State) *Professor of Art and Art Education*
Harlan E. Hoffa, D.Ed. (Penn State) *Professor Emeritus of Art Education*
David B. Van Dommelen, M.A. (Michigan State) *Professor Emeritus of Art Education*
Brent G. Wilson, Ph.D. (Ohio State) *Professor of Art Education*
Marjorie Wilson, D.Ed. (Penn State) *Associate Professor of Art Education*

This program helps students prepare for careers in college teaching, administration, research, public school art teaching, and art supervision.

Admission Requirements

Scores from the Graduate Record Examination (GRE) or from the Miller Analogies Test (MAT) are required for admission. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Students who seek admission to the graduate program must make formal application to the admissions committee of the Art Education program. To be admitted without deficiencies, the student is expected to have completed either a baccalaureate degree in art education or a program considered by the admissions committee to provide an appropriate background for the application's degree objectives. Related programs include work in studio art, art history, art education, education, museum education, etc. Deficiencies may be made up by course work that is not counted as credit toward an advanced degree. Students pursuing graduate degrees may simultaneously take course work leading to teaching certification and art supervisory certification. The students who plan to teach art education at the college level should note that some institutions require professors to hold a public school art teaching certificate and to have had public school teaching experience.

Students with a minimum 3.00 junior/senior grade-point average (on a 4.00 scale) and with appropriate course backgrounds will be considered for admission. The most qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 average may be made for students with special backgrounds, abilities, and interests. Transcripts should indicate high attainment in appropriate academic and creative work. Letters of recommendation should attest to scholarship and ability to work independently. In addition to the above requirements, all applicants must submit an example of scholarly writing and a one- to two-page statement of (1) professional objectives; and (2) the areas in which research and creative work are planned. The statement should indicate how these objectives will be furthered by graduate study. For applications with a studio background, the inclusion of slides of creative work showing the depth and range of studio abilities is also recommended. Teachers may also submit slides of student works. Applicants planning to pursue studio work as a part of their graduate program must submit ten to fifteen slides of their creative work showing the depth and range of their studio abilities.

Master's Degree Requirements

A minimum of 30 graduate credits is required for the master's degree. Students must take a minimum of 15 credits in art education. Of those, M.Ed. and M.S. candidates are expected to complete the following 3-credit core: A ED 502, 505, 536, or 588; and A ED 590 (1 credit for each two semesters enrolled in course work). Students must take additional credits to total a minimum of 15 credits. All master's degree candidates must also complete 6 credit of foundational studies at the 400 level or above in areas such as art history, studio, philosophy, educational theory and policy, educational psychology, psychology, and anthropology. The remaining 9 credits are made up of elective studies.

Additional M.Ed. requirements. For M.Ed. candidates, 12 credits of course work must be at the 500 level or above. In addition to course work, M.Ed. candidates must write a substantial paper or present an exhibition in lieu of a thesis.

Additional M.S. requirements. For M.S. candidates, 18 credits of course work must be at the 500 level or above. M.S. candidates must prepare and orally defend a thesis. Requirements include 6 credits of thesis research within the 30 credits.

Doctoral Degree Requirements

Admission to candidacy. Once admitted to the doctoral program, all students must take a candidacy examination, which usually is given before the end of the first semester that the student is in residence. During the candidacy examination there is a review of (1) the student's professional résumé; (2) a statement regarding the general direction of the student's research interests and possible areas of thesis inquiry; (3) completed graduate courses; (4) proposed course of study for subsequent semesters; (5) selected graduate papers written by the student; (6) slides or original work if studio inquiry is part of the student's program of study.

English competence. At or before the candidacy exam, all candidates for doctoral degrees are required to demonstrate high-level competence in the use of the English language, including reading, writing, and speaking, as part of the requirement for the doctoral program. Competency must be formally attested to by the student's committee before the comprehensive examination is held.

Course requirements. All doctoral students are expected to complete the following 3-credit core courses: A ED 502, 505, 536, 588; and A ED 590 (1 credit for each two semesters enrolled in course work.)

Additional D.Ed. requirements. All D.Ed. students must complete 90 credits of graduate work. (Master's degree work often fulfills part of this requirement.) In addition to the core courses listed above, D.Ed. students must complete 12 credits of course work in education, 12 credits of art studies outside the art education program (studio, art history, criticism, or aesthetics) and 2 additional courses in art education. Students seeking the D.Ed. are required to complete a minor in an acceptable field of study (for example, art, psychology, philosophy, or education). The minor consists of a minimum of 15 credits of course work.

Additional Ph.D. requirements. All Ph.D. students must complete at least 2 continuous semesters of residency after being admitted to candidacy. Although not required by the program, Ph.D. students are strongly encouraged to complete a minor area of study. A foreign language is not required of Ph.D. candidates. Instead, the inquiry and foreign language requirement for the Ph.D. is met through 12 credits of graduate-level course work in a related discipline as determined by the student's committee. All Ph.D. students are required to complete 18 credits of course work in art education. These 18 credits comprise the core courses plus two other courses in art education.

Comprehensive examination. Both Ph.D. and D.Ed. candidates are required to take a written and oral comprehensive examination once their course work is substantially completed. The examination, prepared by the student's doctoral committee, covers all phases of the student's doctoral work both in and outside the field of art education.

Doctoral dissertation. Both Ph.D. and D.Ed. candidates are required to complete a dissertation on a topic of research approved by the student's doctoral committee. The dissertation must be defended before the academic community at a final oral examination.

Student Aid

Graduate assistantships and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

ART EDUCATION (A ED)

- 440. ARTS INSTITUTIONS (3)
- 486. CURRENT PROBLEMS IN ART EDUCATION (2-3)
- 489. ART EXPERIENCES WITH CHILDREN (3)
- 494. SCHOOLS AND MUSEUMS (3)
- 495. INTERNSHIP IN ART EXPERIENCES (15)

ART HISTORY

496. INDEPENDENT STUDIES (1-18)

497. SPECIAL TOPICS (1-9)

502. INTRODUCTION TO RESEARCH IN ART EDUCATION (3) Orientation in research methods; findings and designs related to the study of problems in art education.

505. FOUNDATIONS OF ART EDUCATION (3) An examination of classic theories in art education and their relevance to current developments.

535. ARTS ADMINISTRATION FOR SCHOOLS AND COLLEGES (3) Responsibilities of arts administrators in schools and colleges: program, staff development, supervision, facilities, financing, community relations, governance, and report writing.

536. CURRICULUM DEVELOPMENT IN ART EDUCATION (3) Factors affecting art curriculum decisions, analysis, selection, organization, preparation of curriculum. Evaluation and sources of art curriculum improvement and innovation. Prerequisites: 6 credits of methods.

541. HUMAN DEVELOPMENT IN ART (3) Study of current theories of children's development in the creation and interpretation of art.

545. EVALUATION AND ASSESSMENT IN ART EDUCATION (3) Study of theories of evaluation; application of judgmental criteria; analysis and construction of assessment instruments and scoring procedures. Prerequisites: A ED 490, 501.

560. INTERPRETATION THEORY IN ART EDUCATION (3) Study of theories of interpretation as they apply to works of art; the relationship of interpretation theory to the teaching of art.

570. ARTISTIC CREATION AND THEORIES OF KNOWING (3) A thematically organized course that makes connections between art-making and art as a way of knowing and inquiry.

580. AESTHETICS AND THE TEACHING OF ART (3) Study of the nature and value of aesthetics as part of art curricula in public schools and the relationship between aesthetics and culture.

588. HISTORY OF ART EDUCATION (3) Historical development of philosophies in art education in the United States and abroad.

590. COLLOQUIUM (1-3)

594. RESEARCH TOPICS (1-18)

595. RESEARCH IN ART EDUCATION (1-6) Independent research, under an adviser, to be terminated by a scholarly report proportionately comparable in quality to a master's thesis. Prerequisites: 15 credits in art education at the 400 and 500 levels, including A ED 589.

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

ART HISTORY (ART H)

CRAIG ZABEL, *Head of the Department*

229 Arts II Building

814-865-6326

Degrees Conferred: Ph.D., M.A.

The Graduate Faculty

Brian A. Curran, Ph.D. (Princeton) *Assistant Professor of Art History*

Anthony Cutler, Ph.D. (Emory) *Research Professor of Art History*

Roland E. Fleischer, Ph.D. (Johns Hopkins) *Professor Emeritus of Art History*

Hellmut Hager, Ph.D. (Universität Bonn) *Evan Pugh Professor of Art History*

Heinz Henisch, Ph.D. (Reading) *Research Professor Emeritus of the History of Photography*

Carmen Belen Lord, Ph.D. (Michigan) *Assistant Professor of Art History*

George Mauner, Ph.D. (Columbia) *Distinguished Professor Emeritus of Art History*

Jeanne Chenault Porter, Ph.D. (Michigan) *Associate Professor of Art History*

Susan C. Scott, Ph.D. (Penn State) *Assistant Professor of Art History*

Elizabeth B. Smith, Ph.D. (NYU, Institute of Fine Arts) *Associate Professor of Art History*

Elizabeth Walters, Ph.D. (NYU, Institute of Fine Arts) *Associate Professor of Art History*

Craig Zabel, Ph.D. (Illinois, Urbana-Champaign) *Associate Professor of Art History*

Graduate work is offered in the following areas: Ancient, Medieval, Byzantine, Renaissance, Baroque, Modern, and American art and architectural history.

Admission Requirements

Scores from the Graduate Record Examination (GRE) Aptitude Test (verbal, quantitative, and analytical) are required for admission to the Department of Art History. Special emphasis will be given to the verbal part of the GRE scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Candidates with a 3.00 junior/senior grade-point average and a minimum of 21 credits in art history will be considered for admission to the master's program. Lacking these, a promising candidate may be accepted on condition that deficiencies be remedied, but without graduate degree credit. Applicants to the Ph.D. program must have an M.A. in art history or a closely related field. The best-qualified applicants will be accepted up to the number of spaces that are available for new students.

Master's Degree Requirements

Candidates for the M.A. degree are required to complete a minimum total of 36 credits, including 6 at the 600 level (thesis research) and a master's thesis. At least 6 credits of course work must be in each of the four major areas of Western art historical study (Ancient, Byzantine-Medieval, Renaissance-Baroque, Modern), including at least 3 credits in each at the 500 level. In addition, candidates must demonstrate a reading knowledge of two foreign languages; one of these is German and the other either French or Italian. Competency in one language must be demonstrated before the end of one year of study. A reading knowledge of the second language must be demonstrated before the end of the second year. A master's examination must also be passed before completing the M.A. degree.

Doctoral Degree Requirements

Thirty additional credits, not including doctoral dissertation research, are required for the Ph.D. At least 24 of these credits must be in art history and 3 to 6 must be in a related area outside art history. At least 9 of the art history credits must be at the 500 level, exclusive of Art History 510 and 596. At the discretion of the candidate's doctoral committee, the candidate may be required to take additional specialized courses pertaining to his or her major area of study. The foreign language requirements for the doctorate are the same as those for the master's degree. For students who have received a master's degree from another university, a reading competency in German and in French or Italian must be demonstrated before the end of one year of study. For the Ph.D., a candidacy examination, a comprehensive examination, and a final oral examination must be successfully completed in addition to the student's doctoral dissertation.

Student Aid

Graduate assistantships and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

ART HISTORY (ART H)

- 401. GREEK ART AND ARCHITECTURE (3-9)
- 402. THE ILLUMINATED MANUSCRIPT (3)
- 404. THE ART OF COLONIAL AMERICA (3)
- 405. PIONEERS OF MODERN ARCHITECTURE (3-6)
- 410. TASTE AND CRITICISM IN ART (3)
- 411. ROMAN ART (3-9)
- 412. THE GOTHIC CATHEDRAL (3)
- 414. ITALIAN BAROQUE PAINTING (3)
- 415. THE SKYSCRAPER (3)
- 416. AMERICAN PAINTING: 1876-1913 (3)
- 420. RUSSIAN ARCHITECTURE (3)
- 422. STUDIES IN MEDIEVAL SCULPTURE (3-9)
- 423. STUDIES IN ITALIAN RENAISSANCE ART (3-9)
- 424. MASTERS OF NORTHERN BAROQUE ART (3)
- 430. GOYA AND HIS TIMES (3)
- 432. PROBLEMS IN ICONOLOGY (3-9)
- 435. STUDIES IN MODERN ART (3-6)
- 442. LATE ANTIQUE AND EARLY CHRISTIAN ART (3)
- 450. THE HISTORY OF PHOTOGRAPHY (3)
- 452. BYZANTINE ART (3)
- 454. SPANISH BAROQUE ART (3)
- 456. GIAN LORENZO BERNINI AND THE ARCHITECTURE OF THE FULL BAROQUE IN ROME (3)
- 458. ROMAN ROCOCO ARCHITECTURE AND THE DAWN OF NEOCLASSICISM (3)

ASTRONOMY AND ASTROPHYSICS

464. FRENCH BAROQUE PAINTING (3)
470. AMERICAN PAINTING AND SCULPTURE SINCE 1940 (3)
496. INDEPENDENT STUDIES (1-18)
497, 498. SPECIAL TOPICS (1-9)
499. FOREIGN STUDIES—ART HISTORY (1-12)
510. STUDIES IN ART HISTORY (3-6 per semester) Original investigation in art history, to be pursued independently or concurrently with course work in particular fields.
511. SEMINAR IN ANCIENT ART (3-12) Selected topics from the history of Greek and Roman art.
512. SEMINAR IN MEDIEVAL ART (3-12) Original research into problems dealing with the art of the Middle Ages.
513. SEMINAR IN RENAISSANCE ART (3-12) Investigations in the area of Renaissance art, centering around major masters and monuments.
514. SEMINAR IN BAROQUE ART (3-12) Investigations in the area of baroque art, centering around major masters and monuments.
515. SEMINAR IN MODERN ART (3-12) Lectures, readings, reports, and discussions in the field of modern art.
517. SEMINAR IN EIGHTEENTH-CENTURY ART (3-12) Investigation into themes and problems dealing with eighteenth-century art.
520. SEMINAR IN SPANISH BAROQUE PAINTING (1-6) Specific problems in the history of seventeenth-century Spanish painting.
522. SEMINAR IN BYZANTINE ART (3-12) Specific iconographical and stylistic problems in Byzantine art and its relation to classical antiquity, the medieval West, and Islam.
525. SEMINAR IN MODERN ARCHITECTURE (3-12) Investigation into the works and problems of modern architecture as they relate to the culture of our times.
542. THE ILLUSTRATION OF THE APOCALYPSE (3-6) Studies in the illustration of the Apocalypse, iconographical and stylistic, from the early Christian period through Dürer.
551. HISTORIOGRAPHY OF ART HISTORY (1-6) The relationship between the definition of, and approach to, art-historical problems from Vasari to the present.
552. PROBLEMS IN CONNOISSEURSHIP (3) A study of the problems of authenticating, attributing, and dating paintings and sculpture through internal evidence.
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

ASTRONOMY AND ASTROPHYSICS (ASTRO)

Peter I. Mészáros, *Head of the Department of Astronomy and Astrophysics*
525 Davey Laboratory
814-865-0418

Degrees Conferred: Ph.D., M.S.

The Graduate Faculty

W. Nielsen Brandt, Ph.D. (Cambridge U., UK) *Assistant Professor of Astronomy and Astrophysics*
David N. Burrows, Ph.D. (Wisconsin) *Senior Scientist/Professor of Astronomy and Astrophysics*
Jane Charlton, Ph.D. (Chicago) *Associate Professor of Astronomy and Astrophysics*
Robin Ciardullo, Ph.D. (California, Los Angeles) *Assistant Professor of Astronomy and Astrophysics*
Michael Eracleous, Ph.D. (Columbia) *Assistant Professor of Astronomy and Astrophysics*
Eric D. Feigelson, Ph.D. (Harvard) *Professor of Astronomy and Astrophysics*
Gordon P. Garmire, Ph.D. (MIT) *Evan Pugh Professor of Astronomy and Astrophysics*
Pablo Laguna, Ph.D. (Texas, Austin) *Associate Professor of Astronomy and Astrophysics*
Peter Mészáros, Ph.D. (California, Berkeley) *Professor of Astronomy and Astrophysics*
John A. Nousek, Ph.D. (Wisconsin) *Senior Scientist/Professor of Astronomy and Astrophysics*
Lawrence W. Ramsey, Ph.D. (Indiana) *Professor of Astronomy and Astrophysics*
Donald P. Schneider, Ph.D. (Cal. Tech.) *Associate Professor of Astronomy and Astrophysics*
Steinn Sigurdsson, Ph.D. (Cal. Tech.) *Assistant Professor of Astronomy and Astrophysics*
Peter D. Usher, Ph.D. (Harvard) *Professor of Astronomy and Astrophysics*
Richard A. Wade, Ph.D. (Cal. Tech.) *Associate Professor of Astronomy and Astrophysics*
Daniel W. Weedman, Ph.D. (Wisconsin) *Professor of Astronomy and Astrophysics*

Aleksander Wolszczan, Ph.D. (Copernicus Univ., Poland) *Evan Pugh Professor of Astronomy and Astrophysics*

Graduate instruction and research opportunities are available in both theoretical and observational astronomy and astrophysics. Currently active areas of theoretical research include atomic processes and radiative transfer, statistical astronomy, high-energy astrophysics (including theory of neutron stars, black holes, compact objects, accretion shock dynamics), and relativity and cosmology. Observational areas include spectroscopic, photometric, and radio frequency observations of quasars and galaxies; complementary radio and X-ray studies of active galaxies and young stars; high-resolution spectroscopy of early- and late-type stars, peculiar stars, variable stars, and stellar activity phenomena; satellite observations of ultraviolet and X-ray spectra of stars and galactic sources; X-ray data from HEAO-1, Einstein, and ROSAT observations of galactic and extragalactic X-ray sources and the diffuse X-ray background; sounding rocket and satellite instrumentation of X-ray and EUV telescopes and detectors; and electronic and computer instrumentation.

The center of observational research facilities is the Hobby-Eberly Telescope, located at the McDonald Observatory in West Texas. A complement of facility spectrographs from low to high resolution will be available starting in 1999. This facility, national facilities such as Kitt Peak, Cerro Tololo, Sacramento Peak, and the NRAO Very Large Array, as well as NASA and international satellite observatories, and various national supercomputing centers, are used extensively by Penn State faculty and graduate students.

Admission Requirements

Scores from the Graduate Record Examination (GRE), including the Physics subject test, are required for admission. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Applicants with a bachelor's degree in astronomy or an allied field such as physics, mathematics, or geophysics are given equal consideration for admission. Opportunity to make up possible undergraduate deficiencies is provided. A grade-point average of 3.00 or better for junior-senior courses in astronomy and related subjects is necessary for consideration for admission. Exceptions to these minimum requirements may be made for students with special backgrounds, abilities, and interests.

Degree Requirements

A nonthesis option is available for the M.S. degree.

Because modern astronomy has very close ties with mathematics, physics, and engineering, the program required of a doctoral candidate normally includes some courses in these related fields, in addition to those in astronomy.

Student Aid

Graduate assistantships and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

ASTRONOMY AND ASTROPHYSICS (ASTRO)

- 410. COMPUTATIONAL ASTROPHYSICS (3)
 - 440. INTRODUCTION TO ASTROPHYSICS (3)
 - 451. ASTRONOMICAL TECHNIQUES (2)
 - 452. ADVANCED ASTRONOMY LABORATORY (1)
 - 475W. STARS AND GALAXIES (3)
 - 480. NEBULAE, GALAXIES, AND COSMOLOGY (3)
 - 485. INTRODUCTION TO HIGH-ENERGY ASTRONOMY (3)
 - 492. (AERSP, E E) SPACE ASTRONOMY AND INTRODUCTION TO SPACE SCIENCE (3)
 - 496. INDEPENDENT STUDIES (1–18)
 - 497. SPECIAL TOPICS (1–9)
 - 499. FOREIGN STUDIES (1–12)
 - 501. FUNDAMENTAL ASTRONOMY (3) Fundamental concepts, tools and techniques, and essential results in all branches of modern observational astronomy except planetary.
 - 502. FUNDAMENTAL ASTROPHYSICS (3) Fundamental tools and results of modern astrophysical theory. Gravitation; gas dynamics; radiation processes; radiative transfer; atomic structure and transitions.
 - 504. GALACTIC AND EXTRAGALACTIC ASTRONOMY (3) Physical cosmology and distance scale; dynamics of star clusters and galaxies; photometric and chemical evolution of galaxies and the universe.
- Prerequisites: ASTRO 501, 502.

BIOBEHAVIORAL HEALTH

510. **ASTROPHYSICS (3)** The theory of atomic structure and spectra and the theory of equilibrium statistical mechanics with applications to astrophysical plasmas. Prerequisite: PHYS 410.
513. **OBSERVATIONAL TECHNIQUES IN ASTRONOMY (3)** Theoretical and practical aspects of modern observational astrophysics. Photometry, spectroscopy, stellar classification, detectors, space astronomy, and basic information theory. Prerequisite: ASTRO 440.
515. **ASTROPHYSICAL DATA ANALYSIS (1)** Statistical methods and data-handling techniques as used in astronomy. Least squares fitting; nonlinear regression; data filtering; nonparametric statistics. Prerequisite: ASTRO 440, STAT 501, or equivalent.
528. **RADIATION PROCESSES IN ASTROPHYSICS (3)** General processes of importance in high-energy, radio, and UV-optical-IR astronomy. Emphasis on physical principles of continuum processes. Prerequisite: PHYS 400.
530. **THEORY OF STELLAR ATMOSPHERES (3)** Theory of photospheric structure, radiative processes, and line-formation in the outer layers of stars, and interpretation of stellar spectra. Prerequisite: ASTRO 510.
534. **STELLAR STRUCTURE AND EVOLUTION (3)** Theory of physical processes, structure, and evolutionary changes of stars; nature of intrinsic variable stars; the Hertzsprung-Russell diagram. Prerequisite: ASTRO 510 or PHYS 561.
540. **GALACTIC ASTRONOMY (3)** Phenomenological investigations of the interstellar medium and star formation; the structure, dynamics, and evolution of our and other normal galaxies. Prerequisite: ASTRO 440.
542. **GASEOUS NEBULAE AND INTERSTELLAR MATTER (3)** Theory and observations of galactic nebulae and interstellar medium, and problems related to the formation of stars. Prerequisite: ASTRO 510.
550. **HIGH-ENERGY ASTROPHYSICS (3)** Theory and observations of X-rays and gamma rays from stars, black holes, neutron stars, supernova remnants, and extragalactic objects. Prerequisites: PHYS 400; PHYS 410 or 454.
582. **RADIO ASTRONOMY (3)** Methods of radio astronomy and its contribution to modern astrophysics. Galactic and extragalactic sources, using line, continuum, and interferometric observations. Prerequisite: ASTRO 440.
583. **GALAXIES, QUASARS, AND COSMOLOGY (3)** Structure and population of the Milky Way galaxy, properties of galaxies, properties and nature of quasars, distance scale, and deceleration parameter. Prerequisite: ASTRO 582.
590. **COLLOQUIUM (1-3)**
596. **INDIVIDUAL STUDIES (1-9)**
597. **SPECIAL TOPICS (1-9)**

BIOBEHAVIORAL HEALTH (BB H)

LYNN T. KOZLOWSKI, *Head, Department of Biobehavioral Health*
315 Health and Human Development Building East
814-863-7256

Degree Conferred: Ph.D., M.S.

The Graduate Faculty

Frank M. Ahern, Ph.D. (Hawaii) *Senior Research Scientist, Biobehavioral Health*
John L. Beard, Ph.D. (Cornell) *Associate Professor of Nutrition*
Peter R. Cavanagh, Ph.D. (Royal Free Medical College) *Professor of Locomotion Studies*
Jordan W. Finkelstein, M.D. (NYU) *Professor of Biobehavioral Health and Human Development*
Donald H. Ford, Ph.D. (Penn State) *Professor Emeritus of Human Development*
John Graham, Ph.D. (USC) *Professor of Biobehavioral Health and Human Development; Professor in Charge of the Graduate Program*
Douglas A. Granger, Ph.D. (California) *Assistant Professor of Biobehavioral Health and Human Development and Family Studies*
Byron C. Jones, Ph.D. (Arizona) *Associate Professor of Biobehavioral Health and Pharmacology*
Patricia Koch, Ph.D. (Penn State) *Associate Professor of Biobehavioral Health*
Lynn T. Kozlowski, Ph.D. (Columbia University) *Professor of Biobehavioral Health*
Gerald E. McClearn, Ph.D. (Wisconsin) *Evan Pugh Professor of Human Development and Psychology*

Toni P. Miles, M.D., Ph.D. (Howard) *Professor of Biobehavioral Health; Director, Center for Special Populations and Health*
 Karl Newell, Ph.D. (Univ of Illinois) *Professor of Biobehavioral Health and Exercise and Sport Science; Head, Department of Exercise and Sport Science*
 Mary E. Nicholson, Ph.D. (Cornell) *Professor of Biobehavioral Health*
 Evan G. Pattishall, Jr., Ph.D. (Michigan) *Research Professor Emeritus of Behavioral Science and Health and Human Development*
 Barbara J. Rolls, Ph.D. (Cambridge) *Professor of Biobehavioral Health; Guthrie Chair of Nutrition*
 Mark P. Roy, Ph.D. (London U) *Assistant Professor of Biobehavioral Health*
 Joseph T. Stout, Ph.D. (Penn State) *Research Scientist, Biobehavioral Health*
 Elizabeth J. Susman, Ph.D. (Penn State) *Professor of Human Development and Nursing*
 Judith R. Vicary, Ph.D. (Penn State) *Associate Professor of Biobehavioral Health*
 George P. Vogler, Ph.D. (Colorado) *Associate Professor of Biobehavioral Health*
 Keith E. Whitfield, Ph.D. (Texas Tech) *Assistant Professor of Biobehavioral Health*

The graduate program in Biobehavioral Health (BB H) is an interdisciplinary graduate program provided by the College of Health and Human Development and involving faculty from its departments. The focus of the program is on the interaction of biological, behavioral, sociocultural, and environmental variables in the etiology and prevention of health problems and in the promotion of healthy human development. The program is designed to cultivate competence in basic and applied research, in the evaluation of biobehavioral health intervention strategies, and in university teaching. Graduates are prepared for research, teaching, or policy roles in health care settings, private and public research laboratories, government agencies, and universities including medical schools.

Special resources available in the college that students may draw upon and potentially participate in for their research programs include a Health and Human Development Consultation Center, Nutrition Clinic, and Speech and Hearing Clinic; Centers for Gerontology, the Study of Child and Adolescent Development, Developmental and Health Genetics, Locomotion Studies, Worksite Health Enhancement, and Developmental and Health Research Methodology; special laboratories in Behavioral Endocrinology, Biomechanics, Human Performance, Motor Behavior, and Nutrition; and extensive computer resources. Additional resources, including elaborate mainframe and super computer capabilities, are available in other parts of the University.

Admission Requirements

Scores from the Graduate Record Examination (GRE), or from the Medical College Admission Test (MCAT), are required for admission. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

College graduates with an undergraduate or masters degree, or a health professions degree emphasizing biological and/or behavioral sciences, or an interdisciplinary program combining aspects of these will be considered for admission. Applicants should have a minimum grade-point average of 3.00 (A=4.00), an above-average score on the GRE or MCAT, and three supporting recommendations. At the discretion of the graduate program, exceptions may be made to these requirements for students with special backgrounds, abilities, and interests. Admission will be offered to candidates who are the best qualified, in the judgment of the faculty, taking all factors into account.

Entering students should have a basic background in biological sciences, the behavioral sciences, or a combination of the two. In addition, they should have a basic background in quantitative methods. They should have competence in English, as reflected in a Test of English as a Foreign Language (TOEFL) score of 600 or above. In exceptional cases, superior students who do not meet these requirements may be admitted provisionally, while correcting their deficiencies. This must occur during their first two semesters in the program.

Master's Degree Requirements

M.S. degree candidates must take five core courses in biobehavioral health and 12 additional credits in methods individually designed in consultation with and with the approval of their adviser and committee. All M.S. degree candidates must complete a formal master's thesis or a master's paper. Candidates selecting the thesis option must complete an additional 6 credits of master's thesis research (BB H 600) for a total of 33 credits. Candidates selecting the paper option must complete an additional 6 credits of individual studies (BB H 596) in lieu of the 6 thesis credits. The master's thesis will typically describe original research. The master's program may describe original research, but may also involve a substantial review of the literature, or a substantial description of a new research-related procedure. The choice of thesis or paper options will be made by the student in consultation with the adviser. The student's advisory committee judges the quality and acceptability of the paper or thesis. Additionally, the thesis must be

submitted to, and accept by the Graduate School M.S. candidates' grade-point average of all course work through completion of M.S. degree requirements must be 3.0 or higher.

M.S. program course requirements: BB H core courses (15 credits: BB H 501, 502, 503, 504, 505); other methods courses (12 credits minimum: courses at the 400 or 500 level to be selected in consultation with the student's adviser); research credits (6 credits minimum or 6 thesis credits)

Doctoral Degree Requirements

Formal admission to the doctoral program depends on satisfactory completion of the candidacy examination. This exam is designed to assess the student's potential and academic preparation for doctoral study. The candidacy exam must be completed no later than the end of their second semester in the program for students who enter with a masters or other advanced degree, and no later than their fourth semester for students who enter with a baccalaureate degree.

Communication and Language Requirement. Doctoral students must demonstrate competency in spoken English as judged by the faculty and in technical writing as demonstrated in research papers and/or publications. In addition, they must demonstrate competence in one of the following areas: (1) a foreign language; (2) computer science; (3) college teaching; (4) logic or philosophy of science.

Other Requirements. All students must take five core courses in Biobehavioral Health and 12 additional credits in research methods individually designed in consultation with and with the approval of the student's adviser and committee to develop doctoral-level competence in biobehavioral health and one or more related specialized areas.

BIOBEHAVIORAL HEALTH (BB H)

- 410. DEVELOPMENTAL AND HEALTH GENETICS (3)
- 411. RESEARCH AND APPLICATIONS IN BIOBEHAVIORAL HEALTH (3)
- 415. (HL ED) PLANNING AND DEVELOPMENT OF HEALTH EDUCATION PROGRAMS (3)
- 416. (HL ED) EVALUATION OF HEALTH EDUCATION AND HEALTH PROMOTION PROGRAMS (3)
- 420 (HL ED) DEVELOPING STRESS MANAGEMENT PROGRAMS (3)
- 422. SAFETY EDUCATION (3)
- 432. BIOBEHAVIORAL ASPECTS OF STRESS (3)
- 440. (H P A) PRINCIPLES OF EPIDEMIOLOGY (3)
- 444. (HL ED) HEALTH ISSUES IN EMPLOYEE ASSISTANCE PROGRAMS (3)
- 446. (HL ED) HUMAN SEXUALITY AS A HEALTH CONCERN (3)
- 451. PHARMACOLOGICAL INFLUENCES ON HEALTH (3)
- 452. (NURS, WMNST) WOMEN'S HEALTH ISSUES (3)
- 453. (HL ED) ORIENTATION TO THE HEALTH EDUCATION PRACTICUM (1)
- 456 (HL ED) ADVANCED TECHNIQUES IN SCHOOL AND COMMUNITY HEALTH EDUCATION (3)
- 458. (WMNST) CRITICAL ISSUES IN REPRODUCTION (3)
- 469 (BIOL) NEUROBIOLOGY (3)
- 470 (BIOL) FUNCTIONAL AND INTEGRATIVE NEUROSCIENCE (3)
- 494. RESEARCH PROJECT (1-12)
- 495A. (HL ED) HEALTH EDUCATION PRACTICUM (12)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

- 501. THEORIES OF BIOBEHAVIORAL DEVELOPMENT AND FUNCTIONING (3) Examination of theories for understanding individuals as dynamic biobehavioral structural-functional units developing and functioning through continual environmental interactions.
- 502. (PSY) HEALTH: BIOBEHAVIORAL PERSPECTIVES (3) Introduction to the role of psychology in maintaining health and in treating nonpsychiatric disorders.
- 503. BIOBEHAVIORAL FACTORS IN HEALTH PROMOTION AND DISEASE PREVENTION (3) Defines health and considers the interaction of biological, behavioral, and environmental factors in cultivating health development and preventing illness.
- 504. BIOBEHAVIORAL HEALTH INTERVENTION STRATEGIES (3) Evaluation of intervention strategies from a biobehavioral health context; theories of change processes as they pertain to health are analyzed.
- 505. BIOBEHAVIORAL HEALTH RESEARCH STRATEGIES (3) Research strategies in biobehavioral health investigations are examined. Designs and data analytic models relevant to biobehavioral research are included.

551. WORLD HEALTH PROMOTION (3) Analysis of the various health problems that affect humans throughout the world; emphasis will be placed on personal health issues.
552. CURRENT HEALTH EDUCATION ISSUES (3) Analysis of scientific and political foundations of current issues within health education tasks, with emphasis on research and action implications.
555. WOMEN'S HEALTH STUDIES IN HEALTH EDUCATION (3) Analysis of the status of women as consumers and providers of health education, with emphasis on theories and influencing factors.
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

BIOCHEMISTRY, MICROBIOLOGY, AND MOLECULAR BIOLOGY (BMMB)

RONALD D. PORTER, *Director of Graduate Studies*
455 North Frear
814-863-4903

Degrees Conferred: Ph.D., M.S.

The Graduate Faculty

Susan M. Abmayr, Ph.D. (Rockefeller) *Associate Professor of Molecular Genetics*
Paul Babitzke, Ph.D. (Georgia) *Assistant Professor of Biochemistry and Molecular Biology*
J. Martin Bollinger, Ph.D. (MIT) *Assistant Professor of Biochemistry and Molecular Biology*
Jean E. Brechley, Ph.D. (California, Davis) *Professor of Microbiology and Biotechnology*
Don A. Bryant, Ph.D. (UCLA) *Professor of Biochemistry and Molecular Biology; Ernest C. Pollard Professor in Biotechnology*
Craig E. Cameron, Ph.D. (Case Western) *Assistant Professor of Biochemistry and Molecular Biology*
Pamela H. Correll, Ph.D. (George Washington) *Assistant Professor of Veterinary Science*
Gregory K. Farber, Ph.D. (MIT) *Associate Professor of Chemistry and Biochemistry*
Nina V. Fedoroff, Ph.D. (Rockefeller) *Willaman Professor of Life Sciences and Director, Biotechnology Institute*
James G. Ferry, Ph.D. (Illinois) *Professor of Anaerobic Microbiology*
Richard J. Frisque, Ph.D. (Wisconsin) *Professor of Molecular Virology*
Carol V. Gay, Ph.D. (Penn State) *Professor of Cell Biology and Poultry Science*
David S. Gilmour, Ph.D. (Cornell) *Associate Professor of Molecular and Cell Biology*
John H. Golbeck, Ph.D. (Indiana U) *Professor of Biochemistry and Biophysics*
Roy H. Hemmstedt, Ph.D. (Minnesota) *Professor of Biochemistry*
Ross C. Hardison, Ph.D. (Iowa) *Professor of Biochemistry*
Andrew J. Henderson, Ph.D. (California, Riverside) *Assistant Professor of Veterinary Science*
Wesley C. Hymer, Ph.D. (Wisconsin) *Professor of Biochemistry*
Teh-Hui Kao, Ph.D. (Yale) *Professor of Biochemistry and Molecular Biology*
Zhi-Chun Lai, Ph.D. (Albert Einstein College of Medicine) *Assistant Professor of Biology and Biochemistry and Molecular Biology*
Bernhard Luscher, Ph.D. (Zürich) *Assistant Professor of Biochemistry and Molecular Biology*
Andrea M. Mastro, Ph.D. (Penn State) *Professor of Microbiology and Cell Biology*
Pamela Mitchell, Ph.D. (Columbia) *Assistant Professor of Biochemistry and Molecular Biology*
B. Tracy Nixon, Ph.D. (MIT) *Associate Professor of Biochemistry and Molecular Biology*
Davis Ng, Ph.D. (Northwestern) *Assistant Professor of Biochemistry and Molecular Biology*
Gary H. Perdew, Ph.D. (Oregon State) *Professor of Toxicology and Pathobiology*
Allen T. Phillips, Ph.D. (Michigan State) *Professor of Biochemistry*
Ronald D. Porter, Ph.D. (Duke) *Associate Professor of Microbiology and Molecular Genetics*
B. Franklin Pugh, Ph.D. (Wisconsin) *Associate Professor of Biochemistry and Molecular Biology*
Robert A. Schlegel, Ph.D. (Harvard) *Professor of Biochemistry and Molecular Biology*
Esther Siegfried, Ph.D. (Washington) *Assistant Professor of Biology and Biochemistry and Molecular Biology*

Robert T. Simpson, Ph.D. (Harvard) *Professor and Holder of the Verne M. Willaman Chair in Biochemistry*

Ola Sodeinde, Ph.D. (UMass Medical Center) *Assistant Professor of Biochemistry and Molecular Biology*

Song Tan, Ph.D. (Univ. of Cambridge) *Assistant Professor of Biochemistry and Molecular Biology*

William D. Taylor, Ph.D. (Manchester) *Professor of Biophysics*

Ming Tien, Ph.D. (Michigan State) *Professor of Biochemistry*

Graham H. Thomas, Ph.D. (Edinburgh, Scotland) *Assistant Professor of Biology and Biochemistry and Molecular Biology*

Chen-Pei David Tu, Ph.D. (Cornell) *Professor of Biochemistry and Molecular Biology*

Don M. Wojchowski, Ph.D. (UMass) *Associate Professor of Pathobiology and Veterinary Science, and Biochemistry and Molecular Biology*

Jerry L. Workman, Ph.D. (Michigan) *Associate Professor of Biochemistry and Molecular Biology*

The major goal of the program in Biochemistry, Microbiology, and Molecular Biology is to train students for independent research and teaching in the principal areas of those scientific disciplines. Students may enter the program from a variety of backgrounds such as biochemistry, biology, biophysics, cell biology, chemistry, genetics, microbiology, molecular biology, physics, and other related disciplines. The student's research may begin during the first year. Research areas of faculty include bacterial growth regulation and differentiation, biophysics and biochemistry and molecular biology of photosynthesis, calcium metabolism in skeletal tissues, cell cycle regulation, chromosome organization and structure, control of gene expression, DNA-binding proteins, electron paramagnetic resonance spectroscopy, enzyme kinetics and mechanisms of DNA-acting enzymes, functional genomics, membrane structure and function, metallobiochemistry of iron-sulfur proteins, mobile genetic elements, molecular biology of development, molecular biology of xenobiotic metabolism, prokaryotic sensory transduction, regulation of amino acid metabolism, RNA-binding proteins, RNA structure, self-incompatibility in plants, spermatogenesis and spermatozoan maturation, structure and function of enzymes, virology, and X-ray crystallography.

Admission Requirements

Scores on the Graduate Record Examination (GRE) Aptitude Test (verbal, quantitative, and analytical) plus the Subject Test in Biochemistry, Cell and Molecular Biology, or Chemistry or Biology are normally required for admission. Only under exceptional circumstances will an applicant be considered without these scores. Entering students should have taken courses in biology, organic chemistry, calculus, general physics, genetics, microbiology, and preferably physical chemistry. Any deficiencies may be made up concurrently with graduate studies. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION of the *Graduate Bulletin*.

Admission to the program is based on prior course records and grades, GRE scores, letters of recommendation and interviews. Virtually all students are admitted with the intent of obtaining a Ph.D. degree although a master's degree is obtained in some cases on the way to the Ph.D., or as a final degree.

Master's Degree Requirements

Students must meet the M.S. degree requirements specified by the Graduate School in the *Graduate Bulletin*. In addition, a research thesis must be submitted and defended before a committee of the faculty. In general, the master's program is expected to take about two years beyond a bachelor's degree.

Doctoral Degree Requirements

Admission to Ph.D. candidacy is decided on the basis of the student's performance in courses, research and teaching. In addition, a two-day written candidacy examination is taken at the beginning of the spring semester in the second year. This examination tests the student's ability to utilize what s/he has learned in solving problems based on experimental observations. A comprehensive oral examination is taken before the student's Ph.D. thesis committee within approximately three semesters after the student has been admitted to candidacy. The student is expected to present a written proposal concerning his or her research problem in terms of the relevant current literature, the data that has been gathered and the future directions of the experimentation. Questioning may involve, but is not limited to, that research proposal.

The faculty requires that each student demonstrate the ability to collect, organize and present the results of their research in a professional manner before graduation. This is accomplished by preparing a manuscript based on the Ph.D. thesis research. The manuscript must be written primarily by the student

and submitted for publication in a refereed journal. The final Ph.D. thesis defense is taken before the student's thesis committee at the end of the program. The student must also present a public seminar on the thesis research within the two week period preceding the thesis defense. Generally the Ph.D. degree takes about five years beyond a bachelor's degree.

Other Relevant Information

The director of graduate studies is in charge of advising students about academic and related matters until they have chosen a thesis adviser. Beginning students carry out a series of rotation projects in at least three different faculty laboratories before deciding on a research area. Students generally decide on their thesis research adviser at the end of their first fall semester. Each student must take a total of 18 credits in 400- and 500-level courses, required and elective, from a list approved by the program faculty.

Further course work and research are individually planned by the student and the research adviser in consultation with the Ph.D. thesis committee. The thesis committee is established according to the rules of the Graduate School once Ph.D. candidacy has been attained.

All students are required to participate as teaching assistants in undergraduate laboratory courses as part of their training. Students are required to register for 602 (Supervised Experience in College Teaching) for two semesters.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*. Under normal circumstances, all students admitted and continuing in good standing are provided with graduate assistantship support from University sources and research grants.

BIOCHEMISTRY, MICROBIOLOGY, AND MOLECULAR BIOLOGY (BMMB)

503. BIOCHEMICAL PROBLEM (1–10 per semester) Prosecution of an assigned problem under the guidance of an instructor.

507. SEMINAR IN BIOCHEMISTRY, MICROBIOLOGY, AND MOLECULAR BIOLOGY (1 per semester)

508. CLASSIC PAPERS IN BIOCHEMISTRY, MICROBIOLOGY, AND MOLECULAR BIOLOGY (1) A critical examination of seminal papers in the research literature.

509. ETHICS IN BIOMEDICAL SCIENCE (1) Discussion of ethical issues relevant to scientific research in the biomedical sciences.

510. CURRENT LITERATURE IN MOLECULAR BIOLOGY (1) Discussion and analysis of recent scientific papers that form the core of current literature in molecular biology and related disciplines.

514. MOLECULAR BIOLOGY AND CELLULAR REGULATION (3) Structure, synthesis, and biochemical properties of nucleic acids; protein biosynthesis; control of gene expression; molecular genetics. Prerequisite: B M B 400.

520. CARBOHYDRATES, LIPIDS, AND THEIR INTEGRATED METABOLISM (3) Chemistry of carbohydrates, lipids, and membranes; interrelationships between lipid and carbohydrate biosynthesis and metabolism. Prerequisite: B M B 402.

525. PROTEINS AND ENZYMES (3) Properties of proteins and polypeptides, structural analysis and molecular interactions; enzyme structure, kinetic mechanisms, and control. Prerequisite: B M B 402.

536. GENERAL MICROBIOLOGY (3) Recent advances in microbiology, including immunology, virology, medical microbiology, microbial physiology and diversity and microbial genetics. Prerequisite: MICRB 201.

590. COLLOQUIUM (1–3)

597. SPECIAL TOPICS (1–9)

BIOCHEMISTRY AND MOLECULAR BIOLOGY (B M B)

400. MOLECULAR BIOLOGY OF THE GENE (3)

401. GENERAL BIOCHEMISTRY (2)

402. GENERAL BIOCHEMISTRY (3)

403. EXPERIMENTAL BIOCHEMISTRY (4)

408. LABORATORY INSTRUCTIONAL PRACTICE

411. SURVEY OF BIOCHEMISTRY AND MOLECULAR BIOLOGY

428. PHYSICAL CHEMISTRY WITH BIOLOGICAL APPLICATIONS (3)

430. (BIOL; ENT) DEVELOPMENT BIOLOGY (3)

BIOCHEMISTRY AND MOLECULAR BIOLOGY

- 435. (MICRB; V SC) MEDICAL VIROLOGY (2)
- 437. PHYSIOLOGICAL BIOCHEMISTRY (3)
- 440. STRUCTURE AND FUNCTION OF BIOLOGICAL MEMBRANES
- 443W. LABORATORY IN PROTEIN PURIFICATION AND ENZYMOLOGY (3)
- 444. LABORATORY IN CARBOHYDRATES AND LIPIDS (1)
- 445W. LABORATORY IN MOLECULAR GENETICS (3)
- 450. (MICRB) MICROBIAL/MOLECULAR GENETICS
- 451. SENIOR SEMINAR (1)
- 453. ADVANCED MOLECULAR BIOLOGY LABORATORY (4)
- 460. (MICRB) CELL GROWTH AND DIFFERENTIATION (2)
- 474. PROPERTIES OF BIOLOGICAL MACROMOLECULES (2)
- 475. MUTAGENESIS, CARCINOGENESIS, and DNA REPAIR (2)
- 480. (MICRB) TUMOR VIRUSES AND ONCOGENES (3)
- 498. SPECIAL TOPICS (1-9)
- 499. FOREIGN STUDIES (1-12)

MICROBIOLOGY (MICRB)

- 400. INTRODUCTORY ENVIRONMENTAL MICROBIOLOGY (2)
- 401. MICROBIAL PHYSIOLOGY AND STRUCTURE (3)
- 405A. SEMINAR AND PRACTICUM IN MEDICAL TECHNOLOGY—CHEMISTRY (8)
- 405B. SEMINAR AND PRACTICUM IN MEDICAL TECHNOLOGY—URINALYSIS (1)
- 405C. SEMINAR AND PRACTICUM IN MEDICAL TECHNOLOGY—HEMATOLOGY (6)
- 405D. SEMINAR AND PRACTICUM IN MEDICAL TECHNOLOGY—IMMUNOHEMATOLOGY (5)
- 405E. SEMINAR AND PRACTICUM IN MEDICAL TECHNOLOGY—MICROBIOLOGY (7)
- 405F. SEMINAR AND PRACTICUM IN MEDICAL TECHNOLOGY—SEROBIOLOGY/IMMUNOLOGY (3)
- 408. LABORATORY INSTRUCTIONAL PRACTICE (1-2)
- 410. PRINCIPLES OF IMMUNOLOGY (3)
- 411. SURVEY OF MICROBIOLOGY LITERATURE (1 per semester)
- 412. MEDICAL MICROBIOLOGY (3)
- 413. MICROBIAL DIVERSITY (2)
- 415. BACTERIAL AND ANIMAL VIRUSES (3)
- 416. (BIOTC) MICROBIAL BIOTECHNOLOGY (2)
- 421W. LABORATORY OF GENERAL AND APPLIED MICROBIOLOGY (2)
- 422. MEDICAL MICROBIOLOGY LABORATORY (2)
- 423. ADVANCED LABORATORY IN MICROBIOLOGY (2)
- 435. (B M B; V SC) MEDICAL VIROLOGY (2)
- 447. LABORATORY IN MOLECULAR IMMUNOLOGY (1)
- 450. (B M B) MICROBIAL/MOLECULAR GENETICS (2)
- 460. (B M B) CELL GROWTH AND DIFFERENTIATION (2)
- 476. THE PHOTOSYNTHETIC PROCESS (2)
- 480. (B M B) TUMOR VIRUSES AND ONCOGENES (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497, 498. SPECIAL TOPICS (1-9)
- 499. FOREIGN STUDIES (1-12)

BIOCHEMISTRY AND MOLECULAR BIOLOGY (B M B)

JUDITH S. BOND, *Chair of the Department*
The Milton S. Hershey Medical Center
Hershey, PA 17033
717-531-8585

Degrees Conferred: Ph.D., M.S.

The Graduate Faculty

V. P. Bhavanandan, Ph.D. (Edinburgh) *Professor of Biochemistry and Molecular Biology*

- Keith C. Cheng, M.D., Ph.D. (NYU; Washington) *Associate Professor of Pathology and Assistant Professor of Biochemistry and Molecular Biology*
- Gary A. Clawson, M.D., Ph.D. (Miami; Michigan State) *Professor of Pathology and Biochemistry and Molecular Biology*
- Kristin A. Eckert, Ph.D. (Wisconsin) *Assistant Professor of Pathology, and Biochemistry and Molecular Biology*
- Michael G. Fried, Ph.D. (Yale) *Associate Professor of Biochemistry and Molecular Biology*
- Edwin C. Gillman, M.D., Ph.D. (Penn State) *Assistant Professor of Anesthesiology and Biochemistry and Molecular Biology*
- Charles W. Hill, Ph.D. (Wisconsin) *Professor of Biochemistry and Molecular Biology*
- Anita K. Hopper, Ph.D. (Illinois) *Professor of Biochemistry and Molecular Biology*
- James E. Hopper, Ph.D. (Wisconsin) *Professor of Biochemistry and Molecular Biology*
- Weiping Jiang, Ph.D. (Virginia Polytechnic) *Assistant Professor of Biochemistry and Molecular Biology*
- Ralph L. Keil, Ph.D. (Cornell) *Assistant Professor of Biochemistry and Molecular Biology*
- Momcilo Miljkovic, Ph.D. (Eidg. Technische Hochschule, Zürich) *Associate Professor of Biochemistry and Molecular Biology*
- Ira J. Ropson, Ph.D. (Johns Hopkins) *Assistant Professor of Biochemistry and Molecular Biology*
- Cara-Lynne Schengrund, Ph.D. (Seton Hall) *Professor of Biochemistry and Molecular Biology*
- Ross Shiman, Ph.D. (California) *Professor of Biochemistry and Molecular Biology*

Opportunities for research and graduate study are available in structure and function of macromolecules; genetic, enzymatic, and metabolic regulation; genome organization and stability; regulation of transcription and post-translational modifications.

The program is offered only at the College of Medicine at The Milton S. Hershey Medical Center.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are required for admission. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Students with a 3.00 junior/senior grade-point average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 average may be made for students with special backgrounds, abilities, and interests. Interested students should contact the department chair.

Degree Requirements

The nonthesis option is not available for the M.S. Degree.

Student Aid

Graduate assistantships and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

BIOLOGICAL CHEMISTRY (BCHEM)

502. BIOLOGICAL CHEMISTRY I (3) Structure-function relationships of macromolecules; pathways utilized for energy generation in mammalian systems; concepts of metabolic regulation.
503. (CMBIO, MICRO) MOLECULAR BIOLOGY (3) Principles of molecular and microbial genetics; emphasis placed on experimental design toward problems in bacteria and lower eucaryotes. Prerequisite: BCHEM 502.
505. BIOLOGICAL CHEMISTRY II (3) A continuation of BCHEM 502. Emphasis on interrelations of metabolic pathways, catabolic end products, and regulation. Prerequisite: BCHEM 502.
513. (CMBIO) PRINCIPLES OF PROTEIN STRUCTURE (3) Review of thermodynamics; physical chemistry and architecture of globular proteins; predictive approaches; laboratory in computer modeling of three-dimensional structure; protein-DNA interactions.
520. (CMBIO) GENETIC ANALYSIS (3) Genetics of organisms, including yeast, bacteria, and mice.
551. (CMBIO) KINETICS AND CATALYSIS IN BIOCHEMICAL SYSTEMS (3) Information obtainable from steady-state and transient kinetic measurement on enzymes and cellular processes. Molecular basis for enzyme specificity and catalysis. Prerequisite: BCHEM 502.
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

BIOENGINEERING (BIOE)

HERBERT H. LIPOWSKY, *Head of the Department*

233 Hallowell Building

814-865-1407

814-863-0490 (Fax)

Degrees Conferred: Ph.D., M.S.

The Graduate Faculty

Harry R. Allcock, Ph.D. (London) *Evan Pugh Professor of Chemistry*

Abdellaziz Ben-Jebria, Ph.D. (Paris VI) *Associate Professor of Chemical Engineering*

James G. Brasseur, Ph.D. (Stanford) *Professor of Mechanical Engineering*

Paul W. Brown, Ph.D. (Wisconsin) *Professor of Ceramic Science and Engineering*

Wenwu Cao, Ph.D. (Penn State) *Associate Professor of Mathematics and Materials Science*

Peter R. Cavanagh, Ph.D. (Royal Free Medical) *Distinguished Professor of Locomotion Studies*

Cheng Dong, Ph.D. (Columbia) *Associate Professor of Bioengineering*

David A. Edwards, Ph.D. (Illinois Inst. of Tech.) *Associate Professor of Chemical Engineering*

Arnold A. Fontaine, Ph.D. (Penn State) *Research Associate, Applied Research Laboratory*

Andris Freivalds, Ph.D. (Michigan) *Professor of Industrial Management Systems Engineering*

John F. Gardner, Ph.D., P.E. (Ohio State) *Associate Professor of Mechanical Engineering*

Roger P. Gaumond, D.Sc. (Washington) *Associate Professor of Bioengineering*

David B. Geselowitz, Ph.D. (Pennsylvania) *Distinguished Professor of Bioengineering and Medicine*

William E. Higgins, Ph.D. (Illinois, Urbana-Champaign) *Professor of Electrical Engineering*

Kane M. High, M.D. (Penn State) *Associate Professor of Anesthesia*

Christopher R. Jacobs, Ph.D. (Stanford) *Assistant Professor of Orthopaedics and Engineering Science and Mechanics*

Edward S. Kenney, Ph.D. (Penn State) *Professor Emeritus of Nuclear Engineering*

Herbert H. Lipowsky, Ph.D. (California, San Diego) *Professor of Bioengineering*

Joseph J. McInerney, Ph.D. (Penn State) *Associate Professor of Medicine and Bioengineering*

William S. Pierce, M.D. (Pennsylvania) *Professor Emeritus of Surgery; Chief, Division of Cardiothoracic Surgery*

Joseph L. Rose, Ph.D. (Drexel) *Paul Morrow Professor of Engineering Science and Mechanics in Design and Manufacturing*

Gerson Rosenberg, Ph.D. (Penn State) *Professor of Bioengineering and Research Professor of Surgery*

James Runt, Ph.D. (Penn State) *Professor of Polymer Science*

Neil A. Sharkey, Ph.D. *Associate Professor of Kinesiology, Orthopaedics, and Rehabilitation*

K. Kirk Shung, Ph.D. (Washington) *Professor of Bioengineering*

Michael B. Smith, Ph.D. (Arkansas) *Associate Professor of Radiology; Chief, Center for NMR Research*

Alan J. Snyder, Ph.D. (Penn State) *Associate Professor of Bioengineering and Senior Research Associate in Surgery*

John M. Tarbell, Ph.D. (Delaware) *Distinguished Professor of Chemical Engineering*

James S. Ullman, Ph.D. (Delaware) *Professor of Chemical Engineering*

William J. Weiss, Ph.D. (Penn State) *Assistant Professor of Bioengineering and Research Associate of Surgery*

Robert F. Zelis, M.D. (Chicago) *Professor of Medicine and Physiology*

This intercollege program is designed to provide students with graduate level training in engineering and the life sciences by the application of engineering principles and techniques to the solution of problems in medicine and biology. Graduate instruction in bioengineering is under the direction of a program committee composed of graduate faculty representing several departments in the Colleges of Engineering, Health and Human Development, Science, and Medicine.

Opportunities for specialized research revolve around a delineation of the electrical, mechanical, and biophysical properties of biological materials at the cellular, tissue, and organ levels. Specific applications include: development of artificial organs, with an emphasis on the artificial heart and heart assist devices; cardiovascular hemodynamics, with an emphasis on the structure and function of the capillary network, and blood behavior in contact with the walls of blood vessels and artificial surfaces; cardiac and auditory electrophysiology; lung mechanics and pulmonary function; and non-invasive diagnostic techniques, with an emphasis on ultrasound and X-ray devices and medical imaging. Extensive computer facilities and

specialized equipment are available to support a combination of studies that employ experimental observations and their analysis through mathematical modeling and computer simulations.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are required for admission. However, a student may be admitted provisionally for graduate study in a program without these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Students with a degree in engineering, physics, or the life sciences will be eligible for admission. All students must have a strong background in physics and mathematics. This background should include 6 credits in chemistry, 9 credits in calculus-based physics, and mathematics through calculus and differential equations. Students who lack one or two courses may still be considered for admission but will have to make up any deficiency early in their graduate program. Students with a 3.0 junior/senior grade-point average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces available. Exceptions to the minimum average may be made for students with special backgrounds, abilities, and interests.

Master's Degree Requirements

The particular course of study depends on the student's background and area of research specialization. Courses are selected from the life sciences, engineering, and bioengineering. Course requirements include BIOE 401, 402, and 403 plus two 500-level courses in bioengineering, 6 credits in the life sciences (including BIOL 472), and 6 credits in technically oriented courses outside bioengineering and the life sciences. In addition, students without a previous degree in engineering or physics are required to complete up to 24 additional credits in engineering. Most of this additional course work will be at the undergraduate level and typically includes statics and dynamics, electric circuits and fields, electronic devices, fluid mechanics, and linear systems.

A thesis is required for the M.S. degree. Students must continue to register at appropriate times until the thesis is approved.

Doctoral Degree Requirements

Candidates for the Ph.D. degree generally are expected to complete PHSIO (BIOL) 571–572 plus several additional courses in the life sciences, five courses in bioengineering, and five graduate-level courses in engineering, mathematics, and physics. Supporting courses are available at University Park and The Milton S. Hershey Medical Center in anatomy, biochemistry, biology, biophysics, chemistry, laboratory animal medicine, materials science, mathematics, physics, physiology, and the engineering departments.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by demonstrating intermediate knowledge of an acceptable foreign language, or by taking an advanced technical writing course and presenting a formal proposal for thesis research to the doctoral committee.

Students must continue to register at appropriate times until the thesis is approved.

Student Aid

Graduate assistantships and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

BIOENGINEERING (BIOE)

- 401. INTRODUCTION TO BIOENGINEERING (3)
- 402. BIOMEDICAL INSTRUMENTATION AND MEASUREMENTS (3)
- 403. BIOMEDICAL INSTRUMENTATION LABORATORY (1)
- 419. ARTIFICIAL ORGANS AND PROSTHETIC DEVICES (3)
- 496. INDEPENDENT STUDIES (1–18)
- 497. SPECIAL TOPICS (1–9)

501. (CH E) BIOENGINEERING TRANSPORT PHENOMENA (3) Application of the equations of mass, energy, and momentum conservation to physiological phenomena and to the design of artificial organs.

502. INTRODUCTION TO BIOELECTRIC PHENOMENA (3) Electric phenomena in nerve and muscle, membrane potentials, Hodgkin-Huxley equations, volume conductor problem, applications to electrocardiography, electroencephalography, plethysmography.

503. (CH E) FLUID MECHANICS OF BIOENGINEERING SYSTEMS (3) Cardiovascular system and blood flow, non-Newtonian fluid description, vessel flows, unsteady flows and wave motion, windkessel theory, transmission line theory.

504. **PHYSIOLOGICAL SYSTEM ANALYSIS** (3) Application of systems theory, control theory, and analytic modeling strategies to the study of physiological systems. Prerequisites: BIOL 472, MATH 250.
505. **BIOENGINEERING MECHANICS** (3) Passive and active mechanical properties of tissues, rheological materials, models of muscle contraction, pulmonary mechanics, forces in muscular-skeletal systems.
506. **MEDICAL IMAGING** (3) Medical diagnostic imaging techniques, including generation and detection of X-ray, ultrasound, magnetic resonance, and nuclear radiation; instrumentation and biological effects. Prerequisite: PHYS 202.
507. **BIOMEDICAL SIGNAL PROCESSING** (3) Data acquisition and digital signal processing, focusing on biomedical signal processing issues, including linear-phase filters, spectral analysis, and wavelets. Prerequisites: BIOE 401, 402, BIOL 041 or 472; MATH 250.
515. **CELL MECHANICS AND BIOPHYSICS** (3) Advanced topics and recent developments in cellular engineering; applications of engineering science to cell biology. Prerequisite: BIOE 505.
516. **ULTRASONIC IMAGING** (3) Advanced topics and recent developments in ultrasonic imaging. Prerequisite: BIOE 506.
519. **ARTIFICIAL ORGANS DESIGN** (3) Basic techniques and principles of a multidiscipline approach to artificial organs design.
552. **(E MCH, I E) MECHANICS OF THE MUSCULOSKELETAL SYSTEM** (3) Structure and biomechanics of bone, cartilage, and skeletal muscle; dynamics and control of musculoskeletal system models. Prerequisite: consent of program. Prerequisite or concurrent: BIOL 472.
553. **(I E) ENGINEERING OF HUMAN WORK** (3) Physics and physiology of humans at work; models of muscle strength; dynamic movements; neural control; physical work capacity; rest allocation. Prerequisite: BIOL 041 or 472.
570. **TOPICS IN BIOMEDICAL INSTRUMENTATION** (1) Physiological basis, theory of operation, and practical aspects of clinical instrumentation.
576. **BIOENGINEERING OF THE CARDIOVASCULAR SYSTEM** (3) Experimental and analytical studies of network branching patterns, regional blood flow, rheology and mechanics of blood cells and vessels. Prerequisite: BIOL 472.
580. **BIOENGINEERING INTERNSHIP** (3–6) Supervised experience at The Milton S. Hershey Medical Center, including rotation through services and work on a minor project. Prerequisites: BIOE 402; 3 credits in bioengineering at the 500 level.
590. **BIOENGINEERING COLLOQUIUM** (1-3) Continuing seminars which consist of a series of individual lectures by faculty, students, or outside speakers.
596. **INDIVIDUAL STUDIES** (1–9)
597. **SPECIAL TOPICS** (1–9)

BIOLOGY (BIOL)

WILLIAM R. JEFFERY, *Head of the Department*
208 Erwin W. Mueller Building
814-865-4562

Degrees Conferred: Ph.D., M.S.

The Graduate Faculty

Adam Anthony, Ph.D. (Chicago) *Professor of Biology*
Eva Anton, Ph.D. (Duke) *Assistant Professor of Biology and Neurobiology*
Sarah M. Assmann, Ph.D. (Stanford) *Associate Professor of Biology*
Andrew G. Clark, Ph.D. (Stanford) *Professor of Biology*
Daniel J. Cosgrove, Ph.D. (Stanford) *Professor of Biology*
Richard J. Cyr, Ph.D. (California, Irvine) *Associate Professor of Biology*
Jonathan R. Day, Ph.D. (Delaware) *Assistant Professor of Biology*
Claude W. dePamphilis, Ph.D. (Georgia) *Associate Professor of Biology*
Bertrand D. Eardly, Ph.D. (Oregon State) *Associate Professor of Biology (Berks-Lehigh Valley)*
Nina V. Federoff, Ph.D. (Rockefeller) *Williaman Professor of Life Sciences; Director, Life Sciences Consortium and Biotechnology Institute*
Charles R. Fisher, Ph.D. (California, Santa Barbara) *Associate Professor of Biology*
Hector E. Flores, Ph.D. (Yale) *Associate Professor of Plant Pathology, Biotechnology, and Biology*
Michael Gannon, Ph.D. (Texas Tech) *Associate Professor of Biology (Altoona)*
Simon G. Gilroy, Ph.D. (Edinburgh) *Assistant Professor of Biology*

Mark J. Guiltinan, Ph.D. (California, Arcata) *Associate Professor of Biology, Assistant Professor of Plant Molecular Biology, Department of Horticulture, The Biotechnology Institute*
 Lauraine Hawkins, Ph.D. (New Mexico) *Assistant Professor of Biology (Mont Alto)*
 S. Blair Hedges, Ph.D. (Maryland) *Associate Professor of Biology*
 Dale Holen, Ph.D. (Wisconsin, Milwaukee) *Assistant Professor of Biology (Worthington Scranton)*
 Austin L. Hughes, Ph.D. (Indiana, Bloomington) *Associate Professor of Biology*
 William R. Jeffery Ph.D. (Iowa) *Head; Professor of Biology*
 Zhi-Chun Lai, Ph.D. (Albert Einstein College of Medicine) *Assistant Professor of Biology*
 Bernard Lüscher, Ph.D. (Zürich) *Associate Professor of Biology*
 Hong Ma, Ph.D. (Mass. Med. Inst.) *Associate Professor of Biology*
 James H. Marden, Ph.D. (Vermont) *Associate Professor of Biology*
 Robert B. Mitchell, Ph.D. (Penn State) *Professor of Biology*
 Masatoshi Nei, Ph.D. (Kyoto) *Evan Pugh Professor; Director, Institute of Molecular and Evolutionary Genetics*
 Richard W. Ordway, Ph.D. (Mass. Med. Inst.) *Assistant Professor of Biology*
 Ramesh Raina, Ph.D. (India) *Assistant Professor of Biology*
 Steven W. Schaeffer, Ph.D. (Georgia) *Associate Professor of Biology*
 Robert K. Selander, Ph.D. (California, Berkeley) *Eberly Professor of Biology*
 Esther Siegfried, Ph.D. (Washington Univ., St. Louis) *Assistant Professor of Biology and Biochemistry*
 Andrew G. Stephenson, Ph.D. (Michigan) *Professor of Biology*
 Billie J. Swalla, Ph.D. (Iowa) *Assistant Professor of Biology*
 Graham H. Thomas, Ph.D. (Edinburgh) *Assistant Professor of Biology and Molecular Biology*
 Christopher F. Uhl, Ph.D. (Michigan State) *Associate Professor of Biology*
 Lisa Valburg, Ph.D. (Washington) *Assistant Professor of Biology (Worthington Scranton)*
 Alan Walker, Ph.D. (London) *Professor of Biology and Anthropology*
 Thomas S. Whittam, Ph.D. (Arizona) *Professor of Biology*
 Frederick M. Williams, Ph.D. (Yale) *Associate Professor of Biology*
 James A. Winsor, Ph.D. (Michigan) *Professor of Biology (Altoona)*
 C. B. Wolfe, Ph.D. (Tennessee) *Professor of Biology (Mont Alto)*

The department will direct graduate programs in a broad spectrum of research areas, including biochemistry, biophysics, cell biology, developmental biology, ecology, evolution, genetics, physiology, and systematics. The department houses the Institute of Molecular Evolutionary Genetics. The Ph.D. in Biology may be taken with an option in Molecular Evolutionary Biology or Plant Biology. The courses of study are planned individually by the student and an adviser.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Admission is restricted to students who have the baccalaureate degree in a biological science and who present a cumulative undergraduate average of at least 3.00 on a scale of 4.00. Each applicant must provide a personal statement of interests and objectives and letters from three persons verifying the applicant's academic competence.

Master's Degree Requirements

Students obtaining an M.S. degree in Biology must complete course work as described in the GENERAL INFORMATION section of this bulletin, with guidance from their academic adviser. A thesis is usually required and must be defended before a faculty committee. The research must represent an original contribution, and the time allotted to it is about one year.

Doctoral Degree Requirements

The Ph.D. program is planned by the student's Ph.D. committee after a written and oral candidacy examination is passed. The Ph.D. thesis must represent a significant original contribution and will usually require two or three years of laboratory or field research.

Molecular Evolutionary Biology option: (1) The student must meet the criteria for the M.S. or Ph.D. in Biology. (2) The student's research adviser must be a member of the Biology program and/or a full member of the Institute of Molecular Evolutionary Genetics. Other committee members may be chosen as needed providing that a majority of the committee is associated with the IMEG. (3) In addition to the normal

Biology program requirements, the student must take (for both an M.S. or Ph.D. in Biology) 3 credits of course work in BIOL 591; 9 credits from among the following courses (to be selected in consultation with the student's committee): BIOL 405, 422, 427, 428, 514, 530, (ENT;WILDL) 542, 531, 524, 533, 590, B M B 514. (4) Any other course work or training deemed appropriate by the student's committee.

Plant Biology option: (1) The student must met the criteria for the M.S. or Ph.D. in Biology. (2) The student's research adviser must be a member of the Biology program. Other committee members may be chosen as needed to assure that a well-rounded graduate advisory committee is established. (3) In addition to the normal Biology program requirements, the student must take the required colloquia in the field of specialization and (for both an M.S. or Ph.D. in Biology) a minimum of 6 credits from among the following courses (to be selected in consultation with the student's committee): BIOL 414, 420, 422, 423, 427, 431, 441, 442, 448, 506, 514, 530, 544, 597, HORT 444, B M B 514. (4) Any other course work or training deemed appropriate by the student's committee.

Student Aid

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AID section of the *Graduate Bulletin*, the following awards typically have been available to graduate students in this program:

EBERLY COLLEGE OF SCIENCE BRADDOCK SUPPLEMENT AWARDS

J. BEN AND HELEN D. HILL MEMORIAL FUND SCHOLARSHIP

HENRY W. POPP GRADUATE ASSISTANTSHIP

NATIONAL INSTITUTE OF AGING TRAINEESHIPS—Available to doctoral students in selected graduate programs for research training in adult development and aging; stipend varies. Details available from the Gerontology Center, S-211 Henderson Building.

BIOLOGY (BIOL)

400. TEACHING IN BIOLOGY (2)

404. CELL MECHANISMS OF VERTIBRATE PHYSIOLOGY (3)

405. MOLECULAR EVOLUTION (3)

407. PLANT ANATOMY (3)

408. CONTRIBUTIONS OF WOMEN TO THE BIOLOGICAL SCIENCES: PAST AND PRESENT (3)

409. BIOLOGY OF AGING (3)

410. MOLECULAR BASIS OF PLANT DEVELOPMENT (3)

413. CELL SIGNALING AND REGULATION (3)

414. TAXONOMY OF SEED PLANTS (3)

415. (E R M) ECOTOXICOLOGY (3)

417. INVERTEBRATE ZOOLOGY (4)

418. (PPATH) MYCOLOGY (4)

420. (GEOSC) PALEOBOTANY (3)

421. COMPARATIVE ANATOMY OF VERTEBRATES (4)

422W. ADVANCED GENETICS (3)

423. (GEOSC) INTRODUCTORY PALYNOLOGY (4)

426. INTRODUCTORY CYTOGENETICS (3)

427. (GEOSC) EVOLUTION (3)

428. POPULATION GENETICS (3)

430. (ENT, B M B) DEVELOPMENTAL BIOLOGY (3)

431. COMPARATIVE PLANT MORPHOLOGY (4)

435. ECOLOGY OF LAKES AND STREAMS (3)

437. HISTOLOGY (4)

440. EMBRYOLOGY (4)

441. PLANT PHYSIOLOGY (3)

442. PLANT PHYSIOLOGY (3)

446. PHYSIOLOGICAL ECOLOGY (3)

448. ECOLOGY OF PLANT REPRODUCTION (3)

450W. EXPERIMENTAL FIELD BIOLOGY (5)

454. HERPETOLOGY (2)

460. (ANTH) HUMAN GENETICS (3)

464. (ANTH) SOCIOBIOLOGY (3)

465. GENERAL CYTOLOGY (3)

466. LABORATORY IN CYTOLOGY (1)

469. (BB H) NEUROBIOLOGY (3)
470. (BB H) FUNCTIONAL AND INTEGRATIVE NEUROSCIENCES (3)
471. MOLECULAR NEUROBIOLOGY/CELL BIOLOGY LABORATORY (3)
472. MAMMALIAN PHYSIOLOGY (3)
473. LABORATORY IN MAMMALIAN PHYSIOLOGY (2)
477. BIOLOGY OF HUMAN SEXUALITY (3)
479. GENERAL ENDOCRINOLOGY (3)
482. COASTAL BIOLOGY (4)
496. INDEPENDENT STUDIES (1–18)
- 497, 498. SPECIAL TOPICS (1–9)
498. DEVELOPMENTAL BIOLOGY (3)
499. FOREIGN STUDIES (1–12)
- 499A. TROPICAL FIELD ECOLOGY (3)
501. ECOLOGICAL GENETICS (3) This course will integrate concepts from genetics and ecology, discussing actual data interpreting them in a theoretical context. Prerequisite: BIOL 427.
505. STATISTICAL METHODS IN EVOLUTIONARY GENETICS (3) Statistical methods that are used for analyzing and interpreting genetic data in molecular evolution will be discussed. Prerequisite: BIOL 222, STAT 250.
510. (PLPHY) MOLECULAR BASIS OF PLANT DEVELOPMENT (2) Critical examination of topics related to plant growth and differentiation with an emphasis on plant mutants and genetic engineering. Prerequisite: BIOL 441.
511. ADVANCED PLANT PHYSIOLOGY (3) Physiology of plants, including uptake of water and minerals, translocations, mineral nutrition, energy relations, respiration, and catabolism. Prerequisite: BIOL 442.
512. ADVANCED PLANT PHYSIOLOGY (3) Continuation of BIOL 511. Physiology of plants, including photosynthesis, synthesis of cellular constituents, growth and development. Prerequisite: BIOL 442.
513. PLANT CELLULAR SIGNALING (3) Introduction to themes of plant signaling through critical review of primary literature.
514. TOPICS IN SYSTEMATICS AND EVOLUTION (2) Discussion of pertinent current literature in systematic biology and evolution.
515. (PLPHY) MODERN TECHNIQUES AND CONCEPTS IN PLANT CELL BIOLOGY (2) An intensive introduction to concepts of plant cell biology and modern techniques used in this field. Prerequisite: introductory course in plant physiology.
516. (PLPHY) MODERN TECHNIQUES AND CONCEPTS IN PLANT MOLECULAR BIOLOGY (2) An intensive introduction to contemporary molecular biology methods as applied to the study of plants. Prerequisite: general biology and plant physiology at the undergraduate level.
518. SPECIAL PROBLEMS (1–6) Prosecution of an assigned problem under the guidance of a staff member. Throughout the year as arranged. By appointment.
524. SEMINAR IN GENETICS (1 per semester)
526. (GEOSC) PROBLEMS IN PALYNOLOGY (1–6) Individual research projects in various aspects of palynology, especially palynostratigraphy and paleoecological palynology. Prerequisite: BIOL 423.
542. (ENT, W F S) SYSTEMATICS (3) Principles and methods of classification, phylogeny, and speciation; taxonomic techniques; analysis of species; casual interpretation of animal diversity.
544. ADVANCED PHYSIOLOGICAL ECOLOGY (4) The physiological abilities of plants and animals to adapt to their abiotic environment.
545. ECOSYSTEM DYNAMICS (3) Survey and discussion of recent literature on ecosystem structure and function. Prerequisite: BIOL 210.
546. ECOLOGY OF POPULATIONS (3) Ecological responses of organisms to environmental variables (food, etc.) that determine population behavior. Demography, competition, predation, and community principles.
571. (PHSIO) ANIMAL PHYSIOLOGY (3) Mammalian cardiovascular, respiratory, renal, and gastrointestinal systems. Prerequisite: BIOL 472.
572. (PHSIO) ANIMAL PHYSIOLOGY (3) Mammalian nervous, endocrine, metabolic, and reproductive systems. Prerequisite: BIOL 473.
590. COLLOQUIUM ON SPECIAL TOPICS (1–3)
591. MOLECULAR EVOLUTIONARY BIOLOGY SEMINAR (1) Continuing seminars in Molecular Evolutionary Biology consisting of individual lectures by faculty, students, or outside speakers.

593. (ANTH, ENT, GEOSC, INTAG) TROPICAL FIELD STUDIES (Organization for Tropical Studies)
(8) An intensive field course concentrating on field problems, experimental design, and data analysis in tropical habitats. Prerequisite: approval by the Committee on Tropical Studies.
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3)

BIOSCIENCES, INTEGRATIVE GRADUATE PROGRAM IN

(See INTEGRATIVE GRADUATE PROGRAM IN BIOSCIENCES)

BUSINESS ADMINISTRATION (B A)

KENNETH LUSHT, *Associate Dean for Research and Director of Doctoral and M.S. Programs*
110 Business Administration Building
814-865-7669

ROCKI-LEE DEWITT, *Assistant to the Dean for Professional Masters' Programs*
106 Business Administration Building
814-863-0474

Degrees Conferred: Ph.D., M.S., M.B.A.

The Graduate Faculty

Linda C. Angell, Ph.D. (Boston) *Assistant Professor of Operations Management*
John W. Bagby, J.D. (Tulsa) *Associate Professor of Business Law*
Anantaram Balakrishnan (Massachusetts) *Professor of Management Science and Smeal Chair in MS&IS*
Orrie E. Barron, Ph.D. (Univ. of Oregon) *Assistant Professor of Accounting*
Johann Baumgartner, Ph.D. (Stanford) *Associate Professor of Marketing*
Anne Beatty, Ph.D. (MIT) *Associate Professor of Accounting; Coopers and Lybrand Faculty Fellow*
Donald Bergh, Ph.D. (Colorado) *Assistant Professor of Management*
Stewart W. Bither, Ph.D. (Washington) *Professor of Marketing*
Gary E. Bolton, Ph.D. (Carnegie Mellon) *Associate Professor of Management Science*
Daniel J. Brass, Ph.D. (Illinois) *Professor of Organizational Behavior*
Quanwei (Charles) Cao, Ph.D. (Chicago) *Assistant Professor of Finance*
Joseph L. Cavinato, Jr., Ph.D. (Penn State) *Associate Professor of Business Logistics*
Jennifer Chang, Ph.D. (Northwestern) *Assistant Professor of Marketing*
Kalyan Chatterjee, D.B.A. (Harvard) *Distinguished Professor of Management Science and Economics*
David P. Christy, Ph.D. (Georgia) *Associate Professor of Management Science*
Philip L. Cochran, Ph.D. (Washington) *Associate Professor of Business Administration*
John J. Coyle, Jr., D.B.A. (Indiana) *Professor of Business Administration*
Robert P. Crum, D.B.A. (Kentucky) *Associate Professor of Accounting*
Aniruddha Dasgupta, Ph.D. (Princeton) *Assistant Professor of Management Science*
Alexandru Degeratu, Ph.D. (Univ. of Iowa) *Assistant Professor of Marketing*
Wayne DeSarbo, Ph.D. (Pennsylvania) *The Mary Jean and Frank P. Smeal Distinguished Chaired Professor of Marketing*
Rocki-Lee DeWitt, Ph.D. (Columbia) *Assistant Professor of Management; Director, MBA Program*
Mark W. Dirmsmith, Ph.D. (Northwestern) *Professor of Accounting*
Ian Domowitz, Ph.D. (California, San Diego) *Smeal Chaired Professor of Finance*
Charles R. Enis, D.B.A. (Maryland) *Associate Professor of Accounting*
Rodney Erickson, Ph.D. (Washington) *Professor of Business Administration and Geography*
Peter Everett, Ph.D. (North Carolina) *Associate Professor of Marketing*
J. Russell Ezzell, Ph.D. (Penn State) *Professor of Finance*
Laura Field, Ph.D. (California, Los Angeles) *Assistant Professor of Finance*
Duncan Fong, Ph.D. (Purdue) *Associate Professor of Management Science*
Fariborz Ghadar, D.B.A. (Harvard) *Professor of Finance and William A. Shreyer Chair of Global Management, Policies, and Planning*
Dennis A. Gioia, Ph.D. (Florida State) *Professor of Organizational Behavior*
Marvin Goldberg, Ph.D. (McGill) *Professor of Marketing*

Barbara L. Gray, Ph.D. (Case Western Reserve) *Professor of Organizational Behavior*
 J. D. Hammond, Ph.D. (Pennsylvania) *William Elliott Professor of Insurance and Dean*
 Gordon Hanka, Ph.D. (Chicago) *Assistant Professor of Finance*
 Glen A. Hansen, Ph.D. (Rochester) *Assistant Professor of Accounting*
 David G. Harris, Ph.D. (Michigan) *Assistant Professor of Accounting*
 Mary S. Harris, Ph.D. (Michigan) *Assistant Professor of Accounting*
 Terry P. Harrison Ph.D. (Tennessee) *Professor of Management Science*
 Frank M. Hatheway, Ph.D. (Princeton) *Assistant Professor of Finance*
 Benjamin N. Henszey, M.L.T. (Georgetown) *Professor of Business Law*
 Frances Hollman, Ph.D. (Florida) *Assistant Professor of Marketing*
 Michael P. Hottenstein, D.B.A. (Indiana) *Professor of Management*
 Jingzhi (Jay) Huang, Ph.D. (Northwestern) *Assistant Professor of Marketing*
 Stephen F. Jablonsky, Ph.D. (Illinois) *Associate Professor of Accounting*
 Austin J. Jaffe, Ph.D. (Illinois) *Philip H. Sieg Professor of Business Administration*
 Manish Kacker, Ph.D. (Northwestern) *Assistant Professor of Marketing*
 J. Edward Ketz, Ph.D. (Virginia Polytechnic) *Associate Professor of Accounting*
 Martin Kilduff, Ph.D. (Cornell) *Associate Professor of Organizational Behavior*
 Robert W. Koehler, Ph.D. (Michigan State) *Associate Professor of Accounting*
 Ronald S. Koot, Ph.D. (Oregon) *Professor of Management Science and Associate Dean*
 William Kracaw, Ph.D. (Utah) *Chair, Department of Finance; Professor of Finance*
 Holly S. Lewis, Ph.D. (South Carolina) *Associate Professor of Management Science*
 Gary L. Lilien, D.E.S. (Columbia) *Distinguished Research Professor of Management Science*
 Dennis K. J. Lin (Wisconsin) *Associate Professor of Management Science*
 Kenneth M. Lusht, Ph.D. (Georgia State) *Chair, Department of Insurance and Real Estate; Professor of Business Administration; Associate Dean for Research; Director, Doctoral and M.S. Programs; Zimmerman Endowed University Fellow*
 Nancy McDonnell *Assistant Professor of Business Administration*
 James McKeown, Ph.D. (Michigan State) *Ernst and Young Professor of Accounting*
 Eugene R. Melander, Ph.D. (Minnesota) *Professor of Quantitative Business Analysis*
 James A. Miles, Ph.D. (Penn State) *Professor of Finance; Joseph F. Bradley Fellow of Finance*
 James H. Miller, Ph.D. (Penn State) *Associate Professor of Business Logistics*
 J. Harold Mulherin, Ph.D. (California) *Associate Professor of Finance*
 Karl A. Muller III, Ph.D. (Univ. of Illinois) *Assistant Professor of Accounting*
 Chris J. Muscarella, Ph.D. (Purdue) *Associate Professor of Finance; L. W. "Roy" and Mary Lois Clark Teaching Fellow*
 Jane F. Mutchler, Ph.D. (Illinois) *Arthur Andersen Professor of Accounting*
 Robert A. Novack, Ph.D. (Tennessee) *Associate Professor of Business Logistics*
 Kofi O. Nti, Ph.D. (Yale) *Associate Professor of Management Science*
 Jerry C. Olson, Ph.D. (Purdue) *Chair, Department of Marketing; Earl P. Strong Executive Education Professor*
 J. Keith Ord, Ph.D. (London) *David H. McKinley Professor of Business Administration and Professor of Statistics; Chair, Department of Management Science and Information Systems*
 Michael Pangburn, Ph.D. (Rochester) *Assistant Professor of Operations Management*
 Lisa L. Posey, Ph.D. (Pennsylvania) *Assistant Professor of Business Administration*
 Krishnamoorthy Ramesh, Ph.D. (Michigan State) *Assistant Professor of Accounting*
 Arvand Rangaswamy, Ph.D. (Northwestern) *Associate Professor of Marketing*
 Edward T. Reutzel, Ph.D. (Penn State) *Associate Professor of Management Science*
 Arnold F. Shapiro, Ph.D. (Pennsylvania) *Professor and Robert G. Schwartz University Endowed Fellow of Business Administration*
 Jeffery M. Sharp, Ph.D. (Oklahoma) *Associate Professor of Business Law*
 Dennis P. Sheehan, Ph.D. (California) *Associate Professor of Finance; The Virginia and Louis Benzak Professor of Finance*
 Charles H. Smith, Ph.D. (Penn State) *Chair, Department of Accounting, KPMG Peat Marwick Professor of Accounting*
 Scott A. Snell, Ph.D. (Michigan) *Associate Professor of Management and Organization*
 Charles C. Snow, Ph.D. (California) *Professor of Business Administration*
 John C. Spyckalski, Ph.D., D.B.A. (Indiana) *Professor of Business Logistics*
 Euthemia Stavoulaki, Ph.D. (Rochester) *Assistant Professor of Operations Management*
 H. Kevin Steensma, Ph.D. (Indiana) *Assistant Professor of Management Information Systems*
 Alan J. Stenger, Ph.D. (Minnesota) *Professor of Business Logistics*

John Stevens, Ph.D. (SUNY) *Professor of Management and Organization*

Harish Suján, Ph.D. (UCLA) *Associate Professor of Marketing*

Mita Suján, Ph.D. (UCLA) *Professor of Marketing; Charles and Lillian Binder Faculty Fellow*

Shankar Sundaresan, Ph.D. (Rochester) *Assistant Professor of Management Information Systems*

Gerald I. Susman, Ph.D. (UCLA) *Chair, Department of Management and Organization;*

Robert and Judith Klein Professor of Management

James B. Thomas, Ph.D. (Texas) *Associate Professor of Management; Senior Associate Dean*

Evelyn A. Thomchick, Ph.D. (Clemson) *Associate Professor of Business Logistics*

Linda K. Treviño, Ph.D. (Texas A&M) *Associate Professor of Organizational Behavior*

Charles Trevor, Ph.D. (Cornell) *Assistant Professor of Management and Organization*

Richard Twark, Ph.D. (Penn State) *Associate Professor of Quantitative Business Analysis*

John E. Tyworth, Ph.D. (Oregon) *Chair, Department of Business Logistics; Professor of Business Logistics*

Anthony Verstraete (Penn State) *Senior Lecturer in Management Information Systems*

Theresa Vitolo, Ph.D. (Pittsburgh) *Assistant Professor of Management Information Systems*

Jerome Williams, Ph.D. (Colorado) *Associate Professor of Marketing*

Lisa R. Williams, Ph.D. (Ohio State) *Associate Professor of Business Logistics*

David T. Wilson, Ph.D. (Western Ontario) *Professor of Marketing; Alvin H. Clemens Professor of Entrepreneurial Studies*

J. Randall Woolridge, Ph.D. (Iowa) *Professor of Finance and The Goldman Sachs & Co. and Frank P. Smeal Endowed University Fellow*

Susan H. Xu, Ph.D. (Rensselaer) *Associate Professor of Management Science*

Abdullah Yavas, Ph.D. (Iowa) *Associate Professor of Business Administration*

The Master of Business Administration program is a professional degree designed to prepare individuals for managerial positions in business, government, and nonprofit institutions. The M.B.A. curriculum blends technical rigor, managerial theory, and integrative learning experiences through case studies and other teaching methods. A managerial communications course is fully integrated into the program.

The Master of Science in Business Administration program is highly flexible and designed for advanced study in a specialized field. The M.S. program is directed toward the development of competency within a defined area of management. Fields such as accounting, business logistics, finance, insurance, marketing, management science, and real estate are examples of career opportunities requiring specialized knowledge and skill, including research.

The Doctor of Philosophy degree in the Business Administration program offers advanced graduate education for students contemplating careers in academic teaching and research in non-university settings. The faculty of the college views the Ph.D. as evidencing scholarship at the highest level.

Admission Requirements

Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Applicants to any of the graduate programs in Business Administration are required to take the Graduate Management Admission Test (GMAT), which is administered by the Educational Testing Service throughout a year. For dates, locations, and other information about the test, write for the *Bulletin of Information*, Graduate Management Admission Test, Educational Testing Service, Princeton, NJ 08540.

Criteria for evaluating applicants include professional and academic accomplishments, GMAT scores, recommendations, and personal data from application forms that provide indications of future academic and professional accomplishment.

Work on the M.B.A. degree may be started fall semester only. M.S. and Ph.D. candidates may begin either the fall or spring semester. Individuals from all undergraduate disciplines are encouraged to apply.

While admission to the doctoral program does not require the applicant to hold a master's degree, that is ordinarily the case.

Master's Degree Requirements

The M.B.A. program consists of two distinct portions: (1) preprogram competency expectations, including accounting, economics, mathematics, and statistics; and (2) 48 credits of graduate courses. Individuals who did not have adequate preparation in accounting, economics, mathematics, and statistics in their undergraduate programs are expected to develop the required minimum level of competency before graduate study can begin. The time required to complete this graduate program, based on full-time study, is twenty-one months. The student body is divided into diverse sections of approximately forty students, with each section proceeding through the same core classes each semester. Emphasis is placed on student

interaction and shared learning both inside and outside the classroom.

The M.S. program consists of two distinct portions: (1) approximately 33 acceptable undergraduate foundation credits in business administration, economics, and mathematics; and (2) 30 graduate credits in business administration or related areas, including a paper or thesis. An applicant may be admitted without foundation courses, but they must be made up without degree credit. A professional paper and 3 additional credits of graduate-level course work can be substituted for the thesis. The time required to complete the graduate portion of this program, based on full-time study, is twelve to fifteen months.

Doctoral Degree Requirements

Competency Expectations: Entrance into the doctoral program in business administration does not require the completion of an undergraduate degree specifically in business. While almost any major at the undergraduate level may be acceptable, graduate study in business administration does presume a minimum level of competency in mathematics, statistics, and computing. No transcript credit is required for entering doctoral candidates in these areas, except where specified by particular fields of specialization. However, it must be emphasized that lack of minimum competency in mathematics, statistics and computing could be a significant disadvantage to the candidate.

Breadth Requirement: All candidates are expected to develop a broad understanding of the functions of the business organization. To achieve breadth, all Ph.D. candidates must show competency by completing 12 credits of graduate course work in a minimum of two of the approved fields of study within The Smeal College of Business Administration and in economics. The 12 credits in the breadth requirement must be taken in fields outside or separate from a candidate's primary, supporting, and research competency fields.

Primary Field Requirements: All candidates are required to achieve competency in a primary field of business administration. The primary field is the sphere of scholarship that commands the most extensive and intensive portion of a program and is the area in which the dissertation research and major professors are selected. Primary fields may be selected from the following: accounting; finance/insurance and real estate; management and organization; management science/operations/logistics; and marketing and distribution.

Graduate work in a selected primary field may require competency in prerequisite areas, including undergraduate work in the field itself as well as prior work in mathematics, statistics, computer science, economics, and social and behavioral sciences. The prerequisite work will be specified by each primary field.

Supporting Field Requirements: All candidates must select a supporting field of study from business administration or related outside areas. Those spheres of scholarship complement the candidate's primary field. Supporting fields from business administration include all the primary fields. Outside supporting fields include, but are not limited to, anthropology, civil engineering, computer science, economics, industrial engineering, mathematics, political science, psychology, sociology, and statistics.

Research Methods Field: All candidates must develop a broad understanding of the scientific research process and in-depth competency in the research methods used in the primary field. Each candidate's doctoral committee shall specify a minimum of three graduate-level courses (beyond the M.B.A. core courses) to constitute a supporting field in research methods. One of these courses must focus on the philosophy of science. Others should cover specific methods and tools relevant for research in the primary fields. A member of the doctoral committee shall be designated to represent the research methods field and shall be responsible for evaluating the candidate's competence in the field.

Language and Communication Requirements: All candidates must be competent in the English language and must have demonstrated skills in communicating ideas both orally and in writing commensurate with the requirements of scholarly and professional work. Competency in the English language for candidates whose native language is not English can be demonstrated as follows: (1) a score of 585 (paper-based test) or better on the TOEFL combined with a score of 250 or better on the Test of Spoken English or (2) satisfactory performance in SPCOM 115G.

Satisfactory skills in communicating ideas should be demonstrated by satisfactorily preparing and presenting a working paper for the faculty and peers in the primary field. The language and communication requirements must be satisfied before the scheduling of any portion of the comprehensive examination.

Other Degree Programs

QUALITY AND MANUFACTURING MANAGEMENT MASTERS PROGRAM (QMM)—The QMM program is an integrated, one-year academic program requiring 30 credits and leading to a master's degree in Manufacturing Management. The Penn State College of Engineering and The Smeal College of Business Administration have jointly developed this curriculum so as to integrate the viewpoints and fundamentals of the disciplines on engineering and business as applied to quality and manufacturing management. The objective of the QMM program is to develop graduates who are prepared to assume

leadership positions in manufacturing and to contribute through functional integration to the firm's competitiveness in global markets.

M.B.A./M.H.A. CONCURRENT DEGREE PROGRAM—The MBA Program of The Smeal College of Business Administration and the Department of Health Policy and Administration of the College of Health and Human Development offer a concurrent degree program that will enable a student to finish in two academic years both a master's degree in Business Administration (M.B.A.) and a master's degree in Health Administration (M.H.A.). An M.B.A./M.H.A. graduate will be well-grounded in business management, health management, and the skills and expertise associated with functional areas of health services management. During the two academic years and intervening summer, the student will complete 63 credits of course work and a professional internship of 400 hours in a health care organization.

FIVE-YEAR SCIENCE B.S./M.B.A. PROGRAM—This program is the result of collaboration between the Eberly College of Science and The Smeal College of Business Administration. With the accelerated nature of the program, students can earn a B.S. degree in science and an M.B.A. degree in five calendar years after graduation from high school. For the first three and one-half years, including the first semester of the M.B.A. curriculum, students are enrolled as undergraduates in the Eberly College of Science. For the remaining three semesters, participants are graduate students formally enrolled in The Smeal College of Business Administration M.B.A. program. Successful completion of this program results in a B.S. degree in Science awarded by the Eberly College of Science during year four and an M.B.A. from The Smeal College of Business Administration at the end of year five.

Student Aid

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AID section of the *Graduate Bulletin*, other awards are available to graduate students in The Smeal College of Business Administration. Those awards are published by the college in a separate document.

ACCOUNTING (ACCTG)

Dr. Charles Smith, *Chair*; 814-865-0041

403. AUDITING (4)

404. MANAGERIAL ACCOUNTING (4)

406. ADVANCED FEDERAL TAXATION (3)

413. AUDITING INTERNSHIP (3)

414. MANAGERIAL ACCOUNTING INTERNSHIP (3)

416. FEDERAL INCOME TAX FORM PREPARATION (1)

421. (I B) INTERNATIONAL ACCOUNTING (3)

432. ACCOUNTING INFORMATION SYSTEMS (4)

471. INTERMEDIATE FINANCIAL ACCOUNTING I (3)

472. INTERMEDIATE FINANCIAL ACCOUNTING II (3)

473. ADVANCED FINANCIAL ACCOUNTING (4)

496. INDEPENDENT STUDIES (1-18)

497. SPECIAL TOPICS (1-9)

501. RESEARCH METHODS IN ACCOUNTING (3) An introduction to the methods and techniques of contemporary research in accounting. Prerequisites: ACCTG 504, 507, and a course in statistical inference.

503. SEMINAR IN AUDITING (3) The attest function of independent public accountants, verification of financial statements; problems of evidence, independence, ethics, professional responsibilities. Prerequisite: ACCTG 403.

504. SEMINAR IN MANAGERIAL ACCOUNTING (3-6) Accounting and the managerial process of planning, control, and decision making.

507. SEMINAR IN FINANCIAL ACCOUNTING (3) Theoretical basis of financial accounting.

508. CONTEMPORARY ISSUES IN ACCOUNTING (3) Selected problems of current interest to the accounting profession.

511. FINANCIAL AND MANAGERIAL ACCOUNTING (3) Fundamental financial and managerial accounting concepts and issues from the viewpoint of the report user.

512. FINANCIAL ACCOUNTING THEORY AND REPORTING PROBLEMS (3) Measurement and reporting of financial information for external purposes, with particular attention to current problems in asset and income measurement. Prerequisite: ACCTG 511.

514. SEMINAR IN FEDERAL TAXATION (3) The federal tax structure, including legal, economic, and government implications; focusing on business decisions, research methodology, and tax planning.
515. DEVELOPMENT OF ACCOUNTING THOUGHT (3) Development of accounting thought from ancient civilizations to the present.
516. SEMINAR IN NOT-FOR-PROFIT ACCOUNTING (3) Measurement and structuring of financial information for managerial planning and control and external reporting.
524. MANAGERIAL ACCOUNTING (3) Concepts and techniques of accounting for planning, control, and motivation. Prerequisite: ACCTG 511.
538. DECISION SUPPORT SYSTEMS (3) Analysis of information requirements for planning, decision making, and performance measurement in organizations. Prerequisite: ACCTG 531.
590. COLLOQUIUM (1–3)
596. INDIVIDUAL STUDIES (1–9)
597. SPECIAL TOPICS (1–9)
599. FOREIGN STUDY—ACCOUNTING (1–12)

BUSINESS ADMINISTRATION (B A)

496. INDEPENDENT STUDIES (1–18)
497. SPECIAL TOPICS (1–9)
499. FOREIGN STUDY—BUSINESS ADMINISTRATION (1–18)
500. MARKETING MANAGEMENT (2) Development of a marketing management focus, including market analysis, competition analysis, and decisions in pricing, products, promotion, and distribution channels.
501. MANAGING PEOPLE IN ORGANIZATIONS (2.5) Examination and application of concepts of human behavior to managing people in work organizations.
503. SEMINAR IN PUBLIC UTILITIES (3)
510. OPERATIONS MANAGEMENT (2) Integration and application of decision making to operational and policy problems within the business firm.
511. ACCOUNTING FOR MANAGERIAL DECISION MAKING (2) An integrative approach to the role of accounting information in the investment decision process and implementation of a firm's strategy.
512. QUANTITATIVE ANALYSIS FOR MANAGERIAL DECISION MAKING (2) Construction and use of quantitative methods in business decision making.
513. (PHIL, PSY) PRINCIPLES AND METHODS OF EMPIRICAL SCIENCE (3) Scientific methodologies and their presuppositions, with special emphasis on behavioral and social sciences. Prerequisite: doctoral candidacy in BA/PSY or graduate study in PHIL.
517. COMMUNICATION SKILLS FOR MANAGEMENT (3) Development of communication skills required for management; audience awareness, style, individual and group presentations. Prerequisite: admission to the Master of Business Administration program.
522. STATISTICAL ANALYSIS FOR MANAGERIAL DECISION MAKING (1.5) Use of statistical analysis in understanding business data and making decisions.
531. FINANCIAL MANAGEMENT (3) An intensive examination of techniques available to aid the financial manager in decision making.
533. PRICES AND MARKETS I (2) A survey of analytical concepts and techniques essential to an understanding of the business environment.
534. PRICES AND MARKETS II (1.5) A survey of macroeconomic analytical concepts and techniques essential to an understanding of the business environment.
555. BUSINESS ENVIRONMENT (2) Analysis of ethical, political, social, legal and regulatory, environmental, technological, and demographic diversity environment of business.
560. ENTERPRISE CONSULTING (3) Student groups engaging in consulting relationships with enterprises through use of managerial techniques for identification, analysis, and solution of managerial problems. Prerequisites: B A 511; B A 533; B A 501.
571. STRATEGIC MANAGEMENT (2.5) Analysis and application of strategy concepts and techniques in business organizations.
574. BUSINESS RESEARCH (1–3) A project paper, comparable in quality and scope of work to a graduate thesis, on problems of a company. Prerequisite: 15 credits of 400- and 500-level courses in business administration.
578. ENTREPRENEURSHIP (3) Study of the development or acquisition of a business appropriate to the objectives and resources of the individual entrepreneur.
590. COLLOQUIUM (1–3)
596. INDIVIDUAL STUDIES (1–9)
597. SPECIAL TOPICS (1–9)
599. FOREIGN STUDY—BUSINESS ADMINISTRATION (1–12)

BUSINESS LAW (B LAW)

- 410. CRIMINAL LAW IN THE BUSINESS COMMUNITY (3)
- 425. ENVIRONMENTAL LAW, PROPERTY, AND COMMERCE (3)
- 445. BUSINESS AND PUBLIC LAW (3)
- 471. (ADM J) LEGAL RIGHTS, DUTIES, LIABILITIES OF CRIMINAL JUSTICE PERSONNEL (3)
- 473. (ADM J) CRIMINAL PROCEDURE AND EVIDENCE IN THE BUSINESS COMMUNITY (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
- 575. LEGAL ENVIRONMENT OF THE SECURITIES MARKETS (3) Theoretical/transactional analysis of financial market regulation: securities laws, disclosure, public offerings, insider trading, professional liability, proxies and tender offers.
- 596. INDIVIDUAL STUDIES (1-9)
- 597. SPECIAL TOPICS (1-9)

BUSINESS LOGISTICS (B LOG)

Dr. John E. Tyworth, *Chair*; 814-865-1866

- 400. TRANSPORT PLANNING ANALYSIS (3)
- 405. WAREHOUSE AND TERMINAL MANAGEMENT (3)
- 410. TRANSPORT ECONOMICS AND POLICY (3)
- 415. PROCUREMENT AND CONTRACT LOGISTICS (3)
- 420. URBAN TRANSPORTATION (3)
- 421. LOGISTICS ANALYSIS (3)
- 425W. MANAGEMENT OF LOGISTICS SUPPLY CHAINS (3)
- 430. TRANSPORT PROBLEMS (3)
- 432. LOGISTICS SYSTEMS IN SERVICE INDUSTRIES (3)
- 455. INTERNATIONAL LOGISTICS (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
- 538. LOGISTICS SYSTEMS MANAGEMENT (3) Control of the movement of goods; coordination of supply and demand in creation and maximization of time and place utility.
- 540. TRANSPORT POLICY (3) Role of transport in the economy. Transport systems elements, development cost, and pricing characteristics. Public control and public policies.
- 541. SEMINAR IN PUBLIC TRANSPORTATION POLICY AND MANAGEMENT (3) Role of public transport in social and economic activity, policy, planning, and management topics; analytical methods applied to public transit issues.
- 542. LOGISTICS AND TRANSPORT PLANNING (3) Techniques of analysis for public and private sector project and program decisions.
- 544. LOGISTICS AND TRANSPORT MANAGEMENT (3) Design of optimal strategies for transport and logistics systems management under varying internal and external conditions. Prerequisites: 6 credits in business logistics.
- 546. PROCUREMENT AND SUPPLY MANAGEMENT (3) Analysis, planning, and management of domestic and international procurement and supply activities.
- 560. SEMINAR IN TRANSPORT ECONOMICS AND POLICY (3 per semester, maximum of 6) Comparative analysis of theoretical and empirical studies in transport cost, demand, pricing, and policy problems.
- 565. SEMINAR IN BUSINESS LOGISTICS (3-6)
- 590. COLLOQUIUM (1-3)
- 596. INDIVIDUAL STUDIES (1-9)
- 597. SPECIAL TOPICS (1-9)
- 599. FOREIGN STUDY—BUSINESS LOGISTICS (1-12)

FINANCE (FIN)

Dr. William A. Kracaw, *Chair*; 814-863-0486

- 405. ADVANCED FINANCIAL MANAGEMENT (3)
- 406. SECURITY ANALYSIS AND PORTFOLIO MANAGEMENT (3)
- 407. (I B) MULTINATIONAL FINANCIAL MANAGEMENT (3)
- 408. FINANCIAL MARKETS AND INSTITUTIONS (3)
- 410. SPECULATIVE MARKETS (3)
- 412. COMMERCIAL BANK MANAGEMENT (3)
- 496. INDEPENDENT STUDIES (1-18)

497. SPECIAL TOPICS (1–9)

504. PROBLEMS IN FINANCE (3–6) Planned individual projects involving library, laboratory, or field work.

505. (I B) MULTINATIONAL MANAGERIAL FINANCE (3) Analysis of international aspects of managerial finance. Emphasis on the environmental and institutional factors influencing capital acquisition and allocation. Prerequisite: FIN 531.

506. PORTFOLIO THEORY AND POLICY (3) Rigorous examination and analysis of asset-holder behavior under conditions of risk and uncertainty.

508. ANALYSIS OF FINANCIAL MARKETS (3) Analysis of factors affecting price determination in financial markets.

510. CONTEMPORARY ISSUES IN FINANCIAL INSTITUTIONS (3) Critical investigation of problems of current interest in the market structure and internal operations of financial institutions.

513. SPECULATIVE MARKETS (3) Analysis of derivative securities covering options, forwards, futures, OTC derivatives; topics include valuation, trading, hedging. Involves computer analysis. Prerequisite: B A 531.

532. FINANCIAL DECISION PROCESSES (3) Financial decision making under uncertainty; positive and normative models and current issues in financial management.

541. SECURITY ANALYSIS (3) Discussion and application of analytical techniques in security valuation, including use of computers.

561. SEMINAR IN FINANCE (3–6) Comparative analysis of research in the theories of finance; relationships to business management practices.

590. COLLOQUIUM (1–3)

596. INDIVIDUAL STUDIES (1–9)

597. SPECIAL TOPICS (1–9)

599. FOREIGN STUDY—FINANCE (1–12)

INSURANCE (INS)

Dr. Kenneth Lusht, *Chair*; 814-865-1190

400. ESTATE PLANNING (3)

401. FUNDAMENTALS OF PRIVATE PENSIONS (3)

405. CORPORATE RISK MANAGEMENT (3)

410. COMPOUND INTEREST AND ANNUITIES—CERTAIN (3)

411. LIFE CONTINGENCIES I (3)

412. LIFE CONTINGENCIES II (3)

496. INDEPENDENT STUDIES (1–9)

497. SPECIAL TOPICS (1–9)

500. MANAGEMENT OF THE INSURANCE ENTERPRISE (3) Management planning associated with risk bearing; pricing, reserving, reinsurance, and regulation; Lloyds and other significant world insurance markets; insurance intermediaries.

504. PROBLEMS IN INSURANCE (3) Planned individual projects involving library, laboratory, or field work.

510. RISK MANAGEMENT (3) Analysis of managerial problems and responsibilities of risk analysis, removal or reduction, and allocation of corporate resources to provide indemnity.

596. INDIVIDUAL STUDIES (1–9)

599. FOREIGN STUDY—INSURANCE (1–12)

INTERNATIONAL BUSINESS (I B)

Dr. Fariborz Ghadar, *Director*, 814-865-0544

407. (FIN) MULTINATIONAL FINANCIAL MANAGEMENT (3)

421. (ACCTG) INTERNATIONAL ACCOUNTING (3)

445. (MKTG) GLOBAL MARKETING (3)

496. INDEPENDENT STUDIES (1–18)

497. SPECIAL TOPICS (1–9)

500. INTERNATIONAL BUSINESS MANAGEMENT (3) Concepts and institutions affecting the international conduct of business; interface between nations and international firms; alternative policies businesses employ internationally.

501. COMPARATIVE BUSINESS SYSTEMS (3) Conceptual approach analyzing and predicting influences of social, political, and economic norms and values upon diverse societies' managerial decision making.

502. INTERNATIONAL BUSINESS MACRO ANALYSIS (3) International economic, trade, political, and monetary tools are applied to national policy issues and international business operations. Prerequisite: I B 500.
503. INTERNATIONAL BUSINESS POLICY (3) Analysis of the internal operations of multinational firms; design of optimal strategies of operation under varying environmental conditions. Prerequisite: I B 500.
504. SEMINAR IN INTERNATIONAL BUSINESS (3-6) Seminar in techniques applied to selected topics; market structures; capital budgeting, investment; comparisons of foreign norms and values; multinational organization characteristics.
505. (FIN) MULTINATIONAL MANAGERIAL FINANCE (3) Analysis of the international aspects of managerial finance. Emphasis on the environmental and institutional factors influencing capital acquisition and allocation. Prerequisite: FIN 531.
515. (R EST) INTERNATIONAL REAL ESTATE MARKETS (3) Analysis of economic, financial, legal, and political factors affecting international real estate decision making.
518. (MKTG) GLOBAL MARKETING (3) Role of international marketing in the global business environment; development of marketing plans and implementation strategies under differing socioeconomic conditions. Prerequisite: MKTG 500.
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)
599. FOREIGN STUDY—INTERNATIONAL BUSINESS (1-12)

MANAGEMENT AND ORGANIZATION (MGMT)

Dr. Gerald I. Susman, *Chair*; 814-865-1789

401. CONTEMPORARY ISSUES IN MANAGEMENT (3)
424. INTERPERSONAL RELATIONSHIPS IN ORGANIZATIONS (3)
441. ADVANCED HUMAN RESOURCE MANAGEMENT (3)
- 451W. BUSINESS, ETHICS, AND SOCIETY (3)
461. INTERNATIONAL MANAGEMENT (3)
471. STRATEGIC MANAGEMENT (3)
496. INDEPENDENT STUDIES (1-18)
497. SPECIAL TOPICS (1-9)
501. BEHAVIORAL SCIENCE IN BUSINESS (3) Application of behavioral science concepts and analytical methods to problems in business organizations. Analysis of administrative behavior and decision making.
505. MANAGEMENT OF ADVANCED TECHNOLOGY (3) An analysis of the strategic, organizational, and human resource issues firms must face in order to implement advanced manufacturing technology and practices.
521. POWER AND NEGOTIATION STRATEGIES (3) This course covers strategies and tactics for understanding conflicts, for negotiating effectively, and for dealing successfully with power in organizations.
523. ORGANIZATIONAL CHANGE: THEORY AND PRACTICE (3) Analysis of research, theory, and practice in dynamics of organizational change. Research literature reviewed for evaluation of concepts and methods.
528. SEMINAR IN ORGANIZATIONAL BEHAVIOR (3) Current theoretical and research issues applicable to the study of individual and group behavior within organizational settings.
538. SEMINAR IN ORGANIZATION THEORY (3) Current theoretical and research issues applicable to the study of design and management of complex organizations.
541. HUMAN RESOURCE MANAGEMENT (3) An in-depth examination of the strategic planning and implementation of human resource management, including staffing, development, appraisal, and rewards.
548. SEMINAR IN HUMAN RESOURCE MANAGEMENT (3) Current theoretical and research issues applicable to the study of the design, implementation, and evaluation of human resource practices and programs.
558. SEMINAR IN ORGANIZATIONAL DECISION MAKING (3) An in-depth examination of decision making, including bounded rationality, political behaviors, choice and post-decision processes.
573. CORPORATE INNOVATIVE STRATEGIES (3) Survey of managerial issues involved in formulating and implementing a corporate innovation or technology strategy.
578. SEMINAR IN CORPORATE STRATEGY (3) Current theoretical and research issues applicable to the study of corporate strategy formulation and implementation.

588. SEMINAR IN MULTILEVEL ORGANIZATIONAL RESEARCH (3) The seminar addresses theory, research, and methodological issues surrounding the multilevel integration of micro- and macro-organizational concepts. Prerequisite: MGMT 528, 538, or equivalent.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

599. FOREIGN STUDY—MANAGEMENT (1-12)

MARKETING (MKTG)

Dr. Jerry Olson, *Chair*; 814-865-1869

422. ADVERTISING AND SALES PROMOTION MANAGEMENT (3)

426. BUSINESS MARKETING (3)

428. SALES MANAGEMENT (3)

435. MARKETING AND SOCIETY (3)

437. ADVANCED RETAILING AND MERCHANDISE MANAGEMENT (3)

440. SERVICES MARKETING (3)

445. (I B) GLOBAL MARKETING (3)

450W. MARKETING MANAGEMENT POLICIES AND PROGRAMS (3)

496. INDEPENDENT STUDIES (1-18)

497. SPECIAL TOPICS (1-9)

510. PLANNING MARKETING STRATEGY AND PROGRAMS (3) Development of marketing strategy consistent with corporate plans, including integrated marketing mix programs based on environmental, customer, and competitive analysis. Prerequisite: MKTG 500.

511. QUANTITATIVE ANALYSIS FOR MARKETING DECISIONS (3) Application of quantitative and analytical tools for marketing decisions in forecasting, new product development, advertising, promotions, pricing, and personal selling. Prerequisite: MKTG 500.

512. CONSUMER AND MARKET BEHAVIOR (3) Application of buyer behavior concepts from the behavioral sciences, including utility, culture, life cycle, personality, attitudes, learning, decision making. Prerequisite: MKTG 500.

513. MARKET RESEARCH (3) User-oriented analysis of marketing research process, including problem definition, design, data collection, data analysis, interpretation, and presentation. Prerequisite: MKTG 500.

514. MANAGEMENT OF MARKETING COMMUNICATIONS (3) Management of advertising, sales promotion, and personal selling programs. Topics: segmentation; copy, media, budget decisions; sales territory; and management issues. Prerequisite: MKTG 500.

515. BUSINESS MARKETING (3) Study of marketing of goods and services to business, institutions, and government. Focus on organizational buying, market planning and analysis, and development of marketing mix. Prerequisite: MKTG 500.

516. PRODUCT DEVELOPMENT AND MANAGEMENT (3) Marketing and product strategies for new and old products are covered in this course. Prerequisite: MKTG 500.

517. (MS&IS) BARGAINING AND PROCUREMENT IN A MARKET CONTEXT (3) Bargaining and procurement arrangements between purchases of goods and services and potential suppliers; includes discussion of government procurement. Prerequisite: first-year MBA core requirements.

518. (I B) GLOBAL MARKETING (3) Role of international marketing in the global business environment; development of marketing plans and implementation strategies under differing socioeconomic conditions. Prerequisite: MKTG 500.

551. THEORETICAL PERSPECTIVES ON BUYER BEHAVIOR (3) Review of marketing and social sciences research related to understanding consumer and market behavior.

552. MARKETING THEORY (3) Theory building in marketing; the intricate relation of theory and research.

553. DEVELOPMENT OF MARKETING THOUGHT (1) Analysis of major contributions to the development of marketing thought.

554. RESEARCH METHODS IN MARKETING (3) Philosophical, methodological, and measurement issues involved in designing, conducting, analyzing, and interpreting research in marketing.

555. MARKETING MODELS (3) Topics in the model building approach to marketing decision making, focusing on current research issues.

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

599. FOREIGN STUDY—MARKETING (1-12)

MANAGEMENT SCIENCE AND INFORMATION SYSTEMS (MS&IS)

Dr. J. Keith Ord, *Chair*; 814-865-0073

MANAGEMENT INFORMATION SYSTEMS (M I S)

- 430. INFORMATION SYSTEMS PROCESSING AND DESIGN (3)
- 431. INFORMATION PROCESSING AND DATABASE MANAGEMENT SYSTEMS (3)
- 432. INFORMATION SYSTEMS ANALYSIS, DESIGN, AND IMPLEMENTATION (3)
- 433. INFORMATION SYSTEMS DEVELOPMENT (3)
- 434. TOPICS IN INFORMATION SYSTEMS (3)
- 496. INDEPENDENT STUDIES (1–18)
- 497. SPECIAL TOPICS (1–9)
- 531. MANAGEMENT INFORMATION SYSTEMS (3) Information system theories and methods applied to administrative structures and management decisions in organizations.
- 533. Theoretical, conceptual, and practical issues concerning database design and management in business/industrial management environment. Prerequisite: M I S 531.
- 537. MANAGEMENT INFORMATION SYSTEMS DESIGN (3) Cost, value, and technical considerations in the analysis and design of information systems whose purposes are to aid decision making in organizations. Prerequisite: M I S 531.
- 538. DECISION SUPPORT SYSTEMS (3) Analysis of information requirements for planning, decision making, and performance measurement in organizations. Prerequisite: M I S 531.
- 539. MANAGEMENT OF M I S (3) Organizational issues in managing computer-based information systems. Prerequisites: M I S 531, MGMT 501.
- 599. FOREIGN STUDY—MANAGEMENT INFORMATION SYSTEMS (1–12)

MANAGEMENT SCIENCE AND INFORMATION SYSTEMS (MS&IS)

- 401W. (OPMGT) STATISTICS AND QUALITY CONTROL (3)
- 402. REGRESSION ANALYSIS AND BUSINESS FORECASTING (3)
- 404. SAMPLING IN BUSINESS OPERATIONS AND RESEARCH (3)
- 427. MANAGEMENT DECISION THEORY (3)
- 450. MODELS AND METHODS FOR MANAGERIAL DECISION MAKING (3)
- 452. NONLINEAR PROGRAMMING (3)
- 455. (OPMGT) SIMULATION MODELS OF BUSINESS PROCESSES (3)
- 459. DECISION SUPPORT SYSTEMS (3)
- 461. PROBABILISTIC MODELS IN BUSINESS (3)
- 465. MANAGERIAL FORECASTING (3)
- 496. INDEPENDENT STUDIES (1–18)
- 497. SPECIAL TOPICS (1–9)
- 500. SEMINAR IN BUSINESS STATISTICS (3–6)
- 501. STATISTICAL ANALYSIS FOR BUSINESS (3) Development and use of univariate and bivariate statistical models in the analysis of business decisions with emphasis on data analysis. Prerequisites: CMPSC 203, MS&IS 402.
- 516. (I E) APPLIED STOCHASTIC PROCESSES (3) Discrete and continuous time stochastic processes, including discrete time Markov chains, Poisson processes, continuous time Markov chains, and renewal processes. Prerequisite: I E 322, MS&IS 403, or STAT 318.
- 517. (MKTG) BARGAINING AND PROCUREMENT IN A MARKET CONTEXT (3) Bargaining and procurement arrangements between purchases of goods and services and potential suppliers; includes discussion of government procurement. Prerequisite: first-year MBA core requirements.
- 519. (I E) DYNAMIC PROGRAMMING (3) Deterministic and stochastic dynamic programming. Markov decision processes. Applications to economic and engineering systems. Prerequisite: I E 516 or MS&IS 516.
- 527. ANALYSIS FOR DECISION MAKING UNDER UNCERTAINTY (3) Topics in decision making under uncertainty, including decision theory, Bayesian statistics; payoff function, including utility theory and multi-attribute measures.
- 528. GAME THEORY AND COMPETITIVE DECISION MAKING (3) Concepts, methods, and applications of game theory; modeling and analysis of strategic and competitive situations in business. Prerequisite: MS&IS 501.
- 532. MANAGEMENT SYSTEMS SIMULATION (3) Application of computer simulation to the analysis and design of management decision systems. Design of simulation experiments in business research. Prerequisite: 3 credits of computer programming.
- 533. REGRESSION ANALYSIS FOR BUSINESS DECISIONS (3) The development and use of regression models in the analysis of business decisions. Prerequisites: MATH 220, MS&IS 501.

537. MULTIVARIATE ANALYSIS FOR BUSINESS DECISIONS (3) The development and use of multivariate statistical models in the analysis of business decisions.
540. MATHEMATICAL PROGRAMMING (3) Theory and application of mathematical programming methods. Prerequisite: prior course work in linear programming and linear algebra.
550. SEMINAR IN MATHEMATICAL PROGRAMMING (3–6) discussion of current methods in math programming. Prerequisite: IE 510 or MS&IS 540.
555. (MKTG) MARKETING MODELS (3) Topics in the model building approach to marketing decision making, focusing on current research issues.
565. MANAGERIAL FORECASTING (3) The use of time-series models, including exponential smoothing and Box-Jenkins (ARIMA) techniques for business and economic forecasting.
567. NONPARAMETRIC STATISTICS FOR BUSINESS ANALYSIS (3) The use of nonparametric statistical techniques in the analysis of business decisions.
570. MANAGEMENT SCIENCE: IMPLEMENTATION AND CONTROL (3) Development and application of management science models. Model formulation and specification, sensitivity analysis, problems encountered in implementation and control.
580. TOPICS IN GAME THEORY AND APPLICATIONS (3) Recent developments in game theory and business/economic applications are studied. Students develop and present research ideas—topics vary. Prerequisite: ECON 521.
590. COLLOQUIUM (1–3)
596. INDIVIDUAL STUDIES (1–9)
597. SPECIAL TOPICS (1–9)
599. FOREIGN STUDY—MANAGEMENT SCIENCE AND INFORMATION SYSTEMS (1–12)

OPERATIONS MANAGEMENT (OPMGT)

- 401W. (MS&IS) STATISTICS AND QUALITY CONTROL (3)
416. OPERATIONS PLANNING AND CONTROL (3)
418. MATERIALS MANAGEMENT (3)
419. QUALITY PROGRAM DEVELOPMENT AND IMPLEMENTATION (3)
420. QUALITY ASSURANCE (3)
455. (MS&IS) SIMULATION MODELS OF BUSINESS PROCESSES (3)
496. INDEPENDENT STUDIES (1–18)
497. SPECIAL TOPICS (1–9)
515. MANAGEMENT OF PRODUCTION FACILITIES (3) Examination of research-based findings in operations management, focusing on the design and reliability of production systems.
516. OPERATIONS PLANNING AND CONTROL (3) Examination of research-based findings in operations management. The focus is on the operation and control of production systems.
518. MANAGEMENT OF INVENTORY SYSTEMS (3) Analysis of business organizations as integrated inventory systems. Inventory theory and model building as tools for management decision making. Prerequisite: B A 510, MS&IS 516, or IE 509.
520. MANUFACTURING AND OPERATIONS STRATEGY (3) Examination of the relationship among strategy, structure, and technology in manufacturing (operating) organizations with the goal of creating competitive advantage. Prerequisite: B A 510.
525. TOTAL QUALITY MANAGEMENT (3) Concepts of design, assessment, and improvement of a quality system in an organization. Includes process documentation and international quality standards.
590. COLLOQUIUM (1–3)
596. INDIVIDUAL STUDIES (1–9)
597. SPECIAL TOPICS (1–9)
599. FOREIGN STUDY—OPERATIONS MANAGEMENT (1–12)

REAL ESTATE (R EST)

Dr. Kenneth Lusht, *Chair*; 814-865-1190

400. (B LAW) REAL ESTATE LAW (3)
409. REAL ESTATE FINANCE AND INVESTMENT (3)
425. (B LAW) ENVIRONMENTAL LAW, PROPERTY, AND COMMERCE (3)
440. ADVANCED TECHNIQUES IN REAL ESTATE ANALYSIS (3)
- 450W. URBAN PROPERTY RIGHTS AND LAND USE ISSUES (3)
496. INDEPENDENT STUDIES (1–18)
497. SPECIAL TOPICS (1–9)
499. FOREIGN STUDY—REAL ESTATE (1–12)
510. REAL ESTATE FINANCIAL ANALYSIS (3) Real estate finance and investment analysis. Topics include housing, demand and supply of credit, and real estate investment strategies.

515. (I B) INTERNATIONAL REAL ESTATE MARKETS (3) Analysis of economic, financial, legal, and political factors affecting international real estate decision making.
525. ENVIRONMENTAL LAW (3) Analysis of legal, economic, and social factors affecting the environmental quality of real property and its associated rights.
540. REAL ESTATE FINANCIAL ANALYSIS II (3) Theories and methods of advanced real estate financial analysis.
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)
599. FOREIGN STUDY—REAL ESTATE (1-12)

M.B.A./J.D.—CONCURRENT DEGREE OFFERING WITH THE PENN STATE DICKINSON SCHOOL OF LAW

The Smeal College of Business Administration, University Park campus
The Penn State Dickinson School of Law

Degrees Conferred: J.D. (Dickinson)
M.B.A. (The Smeal College)

Concurrent Degree Program. The Smeal College of Business Administration and the Penn State Dickinson School of Law offer a concurrent degree program leading to the degrees of Juris Doctor (J.D.) and Master of Business Administration (M.B.A.).

Admission to the Program. In order to be admitted to the program, students may: (a) first be admitted and enrolled in either The Smeal College or Dickinson and subsequently admitted to the other program; or (b) be admitted to the concurrent program prior to commencing studies at Penn State. Each program will make a separate admission decision. Students admitted to both programs will be admitted as concurrent degree candidates.

Admission Requirements

Dickinson. A bachelor's or equivalent degree from an accredited college is a prerequisite for admission. However, there is no standard prescribed undergraduate curriculum. An applicant should have acquired significant oral and written communication skills before entering law school. The following are required of applicants: complete application form for Dickinson; results of the Law School Admission Test (LSAT); complete LSDAS report; one-page personal statement; employment record since high school; two recommendations.

MBA program in The Smeal College. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin. Applicants are required to take the Graduate Management Admission Test (GMAT). Criteria for evaluating applicants include professional and academic accomplishments, GMAT scores, recommendations, and personal data from application forms that provide indications of future academic and professional accomplishment. The MBA program also has preprogram competency expectations, including accounting, economics, mathematics, and statistics.

Sequence. Students complete at least one year at University Park campus and one year in Carlisle at Dickinson before being able to cross-count courses. It is anticipated that after one year at each location, a student will spend one more full semester at Smeal and three more semesters at Dickinson.

Transfer of Credits: M.B.A. A maximum of 12 credits: From Dickinson, course work may be transferred toward the M.B.A. degree at The Smeal College, subject to the approval of The Smeal College based on relevance to the MBA program; students must obtain a grade satisfactory to The Smeal College for any J.D. course work to be credited toward the M.B.A. degree.

Transfer of Credits: J.D. A maximum of 12 credits for M.B.A. course work may be transferred for credit toward the J.D. degree at the Dickinson School of Law. Courses for which such credit may be applied shall be subject to approval by the Dickinson faculty. Students must obtain a grade satisfactory to Dickinson for any M.B.A. course work to be credited toward the J.D. degree.

Advising of Students. All students in the program shall have two advisers, one from Smeal and one from Dickinson. Periodic interaction between the two advisers is encouraged.

Graduation. It is anticipated that students will complete a minimum of 36 credits from The Smeal College and 76 credits from the Dickinson School of Law in order to obtain the concurrent M.B.A. and J.D. degrees from those institutions. However, a student can graduate with one degree before the other as long as he/she has completed all of the requirements for that degree.

BUSINESS ADMINISTRATION (B ADM)

JOHN M. MAGENAU, *Director of the M.B.A. Program*
Penn State Erie, The Behrend College
Station Road
Erie, PA 16563

Degree Conferred: M.B.A.

Associate Members of the Graduate Faculty

Stuart J. Allen, Ph.D. (Minnesota) *Associate Professor of Management*
S. Saad Andaleeb, Ph.D. (Illinois) *Associate Professor of Marketing*
Susan J. Chinn, Ph.D. (Kent State) *Assistant Professor of M I S*
Ashutoch V. Deshmukh, Ph.D. (Memphis State) *Assistant Professor of Accounting*
Michael P. D'Itri, Ph.D. (Michigan State) *Assistant Professor of Management*
David T. Doran, Ph.D. (Pittsburgh) *Associate Professor of Accounting*
Joe E. Dowd, Ph.D. (Texas, Austin) *Assistant Professor of Accounting*
John L. Fizel, Ph.D. (Michigan State) *Professor of Economics*
James A. Kurre, Ph.D. (Wayne State) *Associate Professor of Economics*
Kenneth K. T. Louie, Ph.D. (Illinois) *Associate Professor of Economics*
John M. Magenau, Ph.D. (SUNY, Buffalo) *Associate Professor of Management*
Ido Millet, Ph.D. (Pennsylvania) *Assistant Professor of Management Information Systems*
Todd S. Palmer, Ph.D. (Georgia) *Assistant Professor of Management*
Jeffrey K. Pinto, Ph.D. (Pittsburgh) *Associate Professor of Management*
Timothy R. Smaby, Ph.D. (Cincinnati) *Associate Professor of Finance*
Margaret A. Thoms, Ph.D. (Ohio State) *Assistant Professor of Management*
Jeffrey W. Trailer, Ph.D. (Houston) *Assistant Professor of Management*
Ray R. Venkataraman, Ph.D. (Illinois Inst. of Tech.) *Assistant Professor of Management*
Barry R. Weller, Ph.D. (Penn State) *Associate Professor of Economics*
Chester Wolford, Ph.D. (Penn State) *Professor of Business and English*

The Penn State Erie M.B.A. is a general degree emphasizing development of the planning and problem-solving skills crucial in middle and upper management. Course work emphasizes the practical application of theory in the business world, often simulating problems and actual situations students are experiencing at work. Nearly all students are fully employed professionals who bring a wealth of knowledge and experience to the classroom. Both full-time and part-time study are possible and the program can be completed by attending evening and/or Saturday classes.

Admission Requirements

Admission is granted only to candidates who demonstrate high promise of success for graduate work. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Applicants are required to take the Graduate Management Admissions Test (GMAT) administered by the Educational Testing Service, Box 966, Princeton, NJ 08541; telephone (609) 771-7330.

Admission decisions are based on the following: undergraduate grade-point average; work experience; the degree of correspondence between the applicant's objectives and those of the program; three letters of reference; and GMAT score. Entering graduate students for whom English is not the first language are required to have a score of at least 550 on the TOEFL (Test of English as a Foreign Language) examination. Admission is open during the fall and spring semesters, as well as during the summer session.

Master's Degree Requirements

The Master of Business Administration degree program consists of a core of twelve required courses (36 credits) and four elective courses (12 credits). The core courses cover accounting, business environment, communications, economics, finance, information systems, management, marketing, organizations, planning and policy, production and operations management, and statistics. Where appropriate, each core course also contains an international business component.

These core courses develop the qualitative and quantitative reasoning skills that managers need for problem solving. Information systems foster skills in the organization and use of data. The focus of the M.B.A. program is the appropriate use of these tools and skills in solving unstructured problems that involve several functional areas.

Elective courses allow students to pursue a particular area in depth and to gain an appreciation of more complex issues facing managers. Program participants may select from courses in human resources, information systems, international business, marketing, operations management, and quantitative analysis.

Student Aid

Graduate assistantships and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

COURSES

ACCOUNTING (ACNTG)

501. FINANCIAL AND MANAGERIAL ACCOUNTING (3) Comprehensive study of financial accounting: financial information for internal management, planning and special decisions, cost determination, performance evaluation, and control. Prerequisite: ACCTG 200 or 204.

521. ADVANCED ACCOUNTING THEORY (3) Intensive study of accounting principles at an advanced level for students who have had a thorough accounting program. Prerequisite: ACTNG 501.

531. INCOME TAX (3) Tax regulations applicable to partnerships, corporations, estates, and trusts, with emphasis on tax determination and planning.

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

COMMUNICATIONS (COMMU)

501. BUSINESS COMMUNICATIONS (3) A survey of, and practice in, methods and procedures of good business communications.

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

ECONOMICS (ECNS)

501. MANAGERIAL ECONOMICS (3) Application of economic theory to managerial decision making. Prerequisite: ECON 002 or 004.

541. BUSINESS FORECASTING (3) A survey of contemporary business forecasting techniques, including smoothing, decomposition, regression, and time series analysis. Prerequisite: QANLY 501.

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

FINANCE (FNC)

501. FINANCIAL MANAGEMENT (3) Financial management of the firm, with special emphasis on financial planning, capital budgeting, and cost of capital concepts. Prerequisite: ACNTG 501.

531. INVESTMENT THEORY (3) Advanced literature pertaining to investments; special reference to the theory of random walks, stock valuation models, and portfolio management. Prerequisite: FNC 501.

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

INTERNATIONAL BUSINESS (INT B)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

MANAGEMENT (MANGT)

501. PRINCIPLES OF MANAGEMENT (3) An overview of the basic functions of management.
531. ORGANIZATIONS (3) An examination of organizational theories and processes of organizational behavior.
543. LEGAL, POLITICAL, AND SOCIAL ENVIRONMENT OF BUSINESS (3) The interaction of business with society and with the legal and political environments.
545. ENTREPRENEURIAL VENTURES (3) The contribution of the entrepreneur to the enterprise system, supporting public policies and personal requirements for entrepreneurial success. Prerequisites: ACNTG 501, FNC 501.
551. HUMAN RESOURCES MANAGEMENT (3) An overview of areas of human resources management. Prerequisites: MANGT 501.
553. LABOR RELATIONS (3) Labor relations in the modern business organization.
571. STRATEGIC PLANNING AND BUSINESS POLICY (3) Formulation of objectives and implementation of programs to promote long-range success of the organization in a changing environment. Prerequisite: completion of 24 graduate-level credits in the MBA program, including FNC 501, MANGT 501, MRKTG 501.
596. INDIVIDUAL STUDIES (1–9)
597. SPECIAL TOPICS (1–9)

MANAGEMENT INFORMATION SYSTEMS (MISBD)

501. INFORMATION SYSTEMS IN ORGANIZATIONS (3) Understanding and analyzing information in organizations; fundamental concepts of systems and information.
521. SYSTEMS ANALYSIS AND DESIGN (3) Introduces tools of information analysis and requirements specification in organizations; development strategies, management, behavior, problem finding, requirements determination, and specification. Prerequisite: MISBD 501.
531. DATABASE MANAGEMENT SYSTEMS (3) Introduces concepts of file structures, access techniques, data management, models and implementations, database administration, data query, update, and report generation. Prerequisite: MISBD 501.
596. INDIVIDUAL STUDIES (1–9)
597. SPECIAL TOPICS (1–9)

MARKETING (MRKTG)

501. MARKETING (3) Introduces students to marketing's role in society, within the firm, in decision making, information gathering, and in developing marketing mixes.
531. CONSUMER BEHAVIOR (3) An examination of marketing, psychological, sociological factors affecting consumer decision making. Prerequisite: MRKTG 501.
541. MARKETING RESEARCH (3) Examination of marketing research today including research and marketing decisions, sampling and measurement, and collection and analysis of data. Prerequisites: MRKTG 501, QANLY 501.
596. INDIVIDUAL STUDIES (1–9)
597. SPECIAL TOPICS (1–9)

OPERATIONS MANAGEMENT (OPMAN)

501. OPERATIONS MANAGEMENT (3) Quantitative models to aid in the decision-making process connected with operating and controlling the production of goods and services.
596. INDIVIDUAL STUDIES (1–9)
597. SPECIAL TOPICS (1–9)

QUANTITATIVE ANALYSIS (QANLY)

501. STATISTICS FOR MODERN BUSINESS DECISION MAKING (3) A survey of statistical techniques to aid in the decision-making process.
596. INDIVIDUAL STUDIES (1–9)
597. SPECIAL TOPICS (1–9)

BUSINESS ADMINISTRATION (BUSAD)

DAVID J. FRITZSCHE, *Academic Division Head*

Penn State Great Valley
30 East Swedesford Road
Malvern, PA 19355-1443
(610) 648-3378

The Graduate Faculty

Janice L. Dreachslin, Ph.D. (Wayne State) *Associate Professor of Health Policy*

David J. Fritzsche, D.B.A. (Indiana) *Professor of Management and Organization; Division Head*

Veronica M. Godshalk, Ph.D. (Drexel) *Assistant Professor of Management and Organization*

Howard Lin, Ph.D. (Oklahoma State) *Assistant Professor of Marketing*

Effy Oz, D.B.A. (Boston) *Associate Professor of Management Science and Information Systems*

Denise Potosky, Ph.D. (Rutgers) *Assistant Professor of Management and Organization*

Hindupur V. Ramakrishna, Ph.D. (Georgia State) *Associate Professor of Management Science and Information Systems*

John Sosik, Ph.D. (SUNY Binghamton) *Assistant Professor of Management and Organization*

Eric W. Stein, Ph.D. (Pennsylvania) *Associate Professor of Management Science and Information Systems*

Joan Spira, Ph.D. (NYU) *Assistant Professor of Marketing*

Roger C. Vergin, Ph.D. (Minnesota) *Professor of Business Administration*

Premal Vora, Ph.D. (Penn State) *Assistant Professor of Finance*

Degree Conferred: M.B.A.

This program enables students interested in management in the public, private, or nonprofit sectors to pursue integrated programs of study covering the fundamentals of management, the interfaces of the several sectors with one another, and a choice of specializations applicable to one or more of these sectors. A program option is offered in health care administration. Required research in these areas of specialization may be conducted in Penn State Great Valley's Library and Computer Center, which provide local research support as well as access to the library and computer resources of the entire Penn State system.

The MBA program is geared toward the needs of part-time students who are employed full-time. Courses in the program, which are offered at Great Valley, are scheduled for the convenience of adult learners, in the evening or on Saturday.

Admission Requirements

Requirements listed here are in addition to the Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*. Scores from the Graduate Management Admission Test (GMAT) are required for admission. At the discretion of the admissions committee, a student may be admitted provisionally to the program without these scores.

Applicants with a 3.00 junior/senior grade-point average (on a 4.00 scale) and with appropriate course backgrounds will be considered for admission. Special consideration will be given to students with special backgrounds, abilities, and interests. Applicants should have had at least one year of quantitative analysis or statistics.

Admission decisions are based on the quality of the applicant's credentials in relation to those of other applicants. Evaluation criteria include professional and academic accomplishments, GMAT scores, recommendations, and personal data from application materials that provide indications of future academic and professional accomplishment. Application Filing Dates: Applications for fall semester admission may be submitted through August 1, and applications for spring semester may be submitted through December 1.

Degree Requirements

The M.B.A. degree requires 42 hours of graduate-level study. The program consists of a series of core courses, elective courses, and a capstone course.

1. *Core courses* (27 credits): Core courses provide a foundation for business studies. They include MGMT 501, M I S 531, B A 517, MS&IS 510, ACCTG 511, B A 533, MKTG 500, FIN 531, and B A 555.

2. *Elective courses* (12 credits): Elective courses provide an opportunity to obtain more depth in specific functional areas of business and health care administration to meet the career needs and interests of students.

3. *Capstone course* (3 credits): The capstone course MGMT 571 provides a strategic focus and integrates the business disciplines.

4. *Health Care Administration option courses* (42 credits): The core courses listed in No. 1 (above) with H P A 535 replacing FIN 531 and B A 533 not required. H P A 520, H P A 524, one H P A elective plus three additional electives. H P A 556 replaces MGMT 571.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*. Additional information is available from the financial aid office at Penn State Great Valley.

COURSES

ACCOUNTING (ACCTG)

511. FINANCIAL AND MANAGERIAL ACCOUNTING (3) Fundamental financial and managerial accounting concepts and issues from the viewpoint of the report user.

524. MANAGERIAL ACCOUNTING (3) Concepts and techniques of accounting for planning, control, and motivation. Prerequisite: ACCTG 511.

BUSINESS ADMINISTRATION (B A)

517. COMMUNICATION SKILLS FOR MANAGEMENT (3) Development of communication skills required for management; audience awareness, style, individual and group presentations.

533. PRICES AND MARKETS (3) A survey of analytical concepts and techniques available to aid the financial manager in decision making.

555. BUSINESS ENVIRONMENT (3) Analysis of ethical, political, social, legal and regulatory, environmental, technological, and demographic diversity environment of business.

578. ENTREPRENEURSHIP (3) Study of the development or acquisition of a business appropriate to the objectives and resources of the individual entrepreneur.

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

BUSINESS LAW (B LAW)

445. BUSINESS AND PUBLIC LAW (3) Rights and responsibilities of business under the American Constitutional system.

FINANCE (FIN)

504. PROBLEMS IN FINANCE (3) Planned individual projects involving library, laboratory, or field work. The focus will be on case analysis of financial problems in capital structure, capital budgeting, and financial innovation.

505. MULTINATIONAL MANAGERIAL FINANCE (3) Analysis of the international aspects of managerial finance. Emphasis on the environmental and institutional factors influencing capital acquisition and allocation.

506. PORTFOLIO THEORY AND POLICY (3) Rigorous examination and analysis of asset-holder behavior under conditions of risk and uncertainty.

508. ANALYSIS OF FINANCIAL MARKETS (3) Analysis of factors affecting price determination in financial markets.

531. FINANCIAL MANAGEMENT (3) An intensive examination of techniques available to aid the financial manager in decision making.

532. FINANCIAL DECISION PROCESSES (3) Financial decision making under uncertainty; positive and normative models and current issues in financial management.

HEALTH POLICY AND ADMINISTRATION (H P A)

520. HEALTH CARE ORGANIZATIONS (3) Examination of health systems, organizations, financing, and evaluation. Trends, problems, and issues.

524. MANAGEMENT OF HEALTH SERVICES ORGANIZATIONS (3) A systematic study of the roles of health services managers and the organizational and environmental context within which they work.

535. FINANCIAL MANAGEMENT IN HEALTH INSTITUTIONS (3) The financial environment of health institutions; financial aspects of management decision making; emphasis on reimbursement, capital investment, and financing.

536. **HEALTH LAW (3)** The legal process as it applies to the health administration, health organization medical provider, and patient.

547. **HEALTH SERVICES REIMBURSEMENT (3)** Analysis of third party reimbursement of health care providers.

556. **STRATEGY DEVELOPMENT IN HEALTH SERVICES ORGANIZATIONS (3)** Integration of prior course work in the program to develop a strategic plan for a health services organization.

INTERNATIONAL BUSINESS (I B)

500. **INTERNATIONAL BUSINESS MANAGEMENT (3)** Concepts and institutions affecting the international conduct of business, interface between nations and international firms, and alternative policies business employ internationally.

MANAGEMENT AND ORGANIZATION (MGMT)

501. **BEHAVIORAL SCIENCE IN BUSINESS (3)** Application of behavioral science concepts and analytical methods to problems in business organizations. Analysis of administrative behavior and decision making.

523. **ORGANIZATIONAL CHANGE: THEORY AND PRACTICE (3)** Analysis of research, theory, and practice in dynamics of organizational change. Research literature reviewed for evaluation of concepts and methods.

541. **HUMAN RESOURCES MANAGEMENT (3)** An in-depth examination of the roles of the human resources professional, and application of roles to the positions of traditional training designer and developer, internal human resources consultant, internal and external performance technology consultant, and organizational development specialist.

571. **STRATEGIC MANAGEMENT (3)** Analysis and application of strategy concepts and techniques in business organizations.

573. **CORPORATE INNOVATIVE STRATEGIES (3)** Survey of managerial issues involved in formulating and implementing a corporate innovation or technology strategy.

MARKETING (MKTG)

500. **MARKETING MANAGEMENT (3)** Development of a marketing management focus, including market analysis, competitive analysis, and decisions in pricing, product, promotion, and distribution.

512. **CONSUMER MARKET BEHAVIOR (3)** Application of buyer behavior concepts from the behavioral sciences, including utility, culture, life cycle, personality, attitudes, learning and decision making.

513. **MARKET RESEARCH (3)** User-oriented analysis of marketing research process, including problem definition, design, data collection, data analysis, interpretation, and presentation.

515. **BUSINESS MARKETING (3)** Study of marketing of goods and services to business, institutions, and government. Focus on organizational buying, market planning and analysis, and development of marketing mix.

518. **GLOBAL MARKETING (3)** Role of international marketing in the global business environment and development of marketing plans and implementation strategies under differing socioeconomic conditions.

MANAGEMENT SCIENCE AND INFORMATION SYSTEMS (MS&IS)

510. **STATISTICAL ANALYSIS FOR MANAGERIAL DECISION MAKING (3)** Use of statistical methods for managerial decision making, with emphasis on problem formulation, data analysis and interpretation, and business applications.

MANAGEMENT INFORMATION SYSTEMS (M I S)

531. **MANAGEMENT INFORMATION SYSTEMS (3)** Information system theories and methods applied to administrative structures and management decisions in organizations.

538. **DECISION SUPPORT SYSTEMS (3)** Analysis of information requirements for planning, decision making, and performance measurement in organizations.

539. **MANAGEMENT OF M I S (3)** Organizational issues in managing computer-based information systems.

OPERATIONS MANAGEMENT (OPMGT)

510. **OPERATIONS MANAGEMENT (3)** Integration and application of decision making to operational and policy problems within the business firm.

BUSINESS ADMINISTRATION (BADMN)

Director of Graduate Studies

Penn State Harrisburg
School of Business Administration
777 West Harrisburg Pike
E-355 Olmsted Building
Middletown, PA 17057-4898
717-948-6140

Degree Conferred: M.B.A.

The Graduate Faculty

Parvez Ahmed, Ph.D. (Texas, Arlington) *Assistant Professor of Finance*
Melvin Blumberg, Ph.D. (Penn State) *Professor of Management*
Karen L. Brown, D.B.A. (Louisiana Tech) *Assistant Professor of Operations Management*
Terence A. Brown, D.B.A. (Maryland) *Associate Professor of Transportation and Marketing*
David Bukovinsky, Ph.D. (Kentucky) *Assistant Professor of Professional Accountancy*
Refik Culpun, Ph.D. (NYU) *Professor of Management and International Business*
Jacob De Rooy, Ph.D. (Rutgers) *Associate Professor of Managerial Economics and Statistics*
Carolyn R. Dexter, Ph.D. (Columbia) *Professor of Management and Marketing*
Krishna S. Dhir, Ph.D. (Colorado) *Professor of Business Administration*
Janet Greenlee, Ph.D. (Kentucky) *Assistant Professor of Professional Accountancy*
Jean Harris, Ph.D. (Virginia) *Associate Professor of Professional Accountancy*
Erdener Kaynak, Ph.D. (Cranfield) *Professor of Marketing*
Mehdi Khosrowpour, D.B.A. (Nova) *Associate Professor of Information Systems*
Mukund S. Kulkarni, Ph.D. (Kentucky) *Associate Professor of Finance*
Ching-Chung Kuo, Ph.D. (Northwestern) *Associate Professor of Operations Management*
Robert Larson, Ph.D. (Utah) *Associate Professor of Professional Accountancy*
David A. Morand, Ph.D. (Cornell) *Associate Professor of Management*
Vedula N. Murti, Ph.D. (Pennsylvania) *Assistant Professor of Economics and Statistics*
Sudhir Nanda, Ph.D. (Massachusetts) *Assistant Professor of Finance*
Rosalie Ocker, Ph.D. (Rutgers) *Assistant Professor of Information Systems*
Kurt H. Parkum, Ph.D. (Wisconsin) *Associate Professor of Management*
Parag C. Pendharkar, D.B.A. (Southern Illinois) *Assistant Professor of Information Systems*
Robert D. Russell, Ph.D. (Pittsburgh) *Assistant Professor of Management*
Stephen P. Schappe, Ph.D. (Ohio State) *Assistant Professor of Information Management*
Girish Subramanian, Ph.D. (Temple) *Associate Professor of Information Systems*
John M. Trussel, Ph.D. (George Washington) *Assistant Professor of Professional Accountancy*
Gayle J. Yaverbaum, Ph.D. (Temple) *Associate Professor of Information Systems*
Ugur Yucelt, Ph.D. (New School) *Associate Professor of Marketing*

Students served by the M.B.A. program are, primarily, nontraditional and reside in south-central Pennsylvania. With the exception of a small percentage of students who are full-time, they are employees of area businesses, state and local governments, and not-for-profit organizations, who study on a part-time basis. In order to accommodate both full- and part-time students, courses are offered primarily in the evening.

The program is intended not only to satisfy current individual needs for professional growth, but also to foster lifelong learning. As an outcome of the program, students may expect to gain problem-solving skills as well as technical expertise, critical thinking skills, desirable attitudes and values, and participative strengths.

To strengthen the educational experience, the curriculum places high priority on teaching and currency of curriculum. Oral and written communication, research, integration of concepts throughout the curriculum and cross-functional approaches are emphasized.

Admission Requirements

Those wishing to apply to the program must hold a baccalaureate degree in any field from a regionally accredited, college-level institution. Decision are based primarily on undergraduate junior/senior grade-point average and the Graduate Management Admission Test (GMAT) scores. Postbaccalaureate course

work, professional experience, and the statements provided in the application are also taken into account.

Students are also required to submit:

- a completed application form
- two copies of official transcripts from all colleges or universities attended
- scores from the GMAT test (the test must have been taken within the past five years)
- an application fee
- letters of recommendation (optional)

The Test of English as a Foreign Language (TOEFL) must be taken by applicants for whom English is not their first language. The test must be passed with a score (for written test, not computerized test) of 550 or higher and must have been completed within the past five years.

Please contact the Enrollment Services Office, (717) 948-6250 or (800) 222-2056, to request an application form or ask questions regarding the admission procedure.

Entrance into the Program

Candidates may enter the program at the beginning of the fall or spring semester, or the summer session. To allow time for applications to be processed, all information, including the GMAT score, must be received by the admissions office no later than July 18 for admission to the fall semester, November 18 for the spring semester, and April 18 for admission to the summer session.

Applicants from outside the United States must follow the early-admission dates in order to allow the necessary clearances and paperwork to be processed in time.

Preparation for the Program

Mathematics Requirement: Prior to enrolling in their M.B.A. course work, students are required to demonstrate competence in quantitative skills. This may be demonstrated by: (1) satisfactory completion of a college-level calculus course, such as QUANT 310 Mathematical Methods in Social and Managerial Sciences or (2) successful completion of a mathematics proficiency examination approved by the MBA program. This requirement must be satisfied either during the first semester or summer session of the student's matriculation and completed with a grade of C or better.

Credit by examination: Interested students should obtain a Credit by Examination form from Enrollment Services and should consult with the mathematics faculty in the School of Science, Engineering, and Technology to schedule the exam and obtain a list of suggested preparatory materials.

Computer Requirement: Students are required to demonstrate competence through a college-level microcomputer applications course within the past six years (and passed with at least a B) or significant work experience. If this requirement has not been met, a college-level microcomputer course such as INFSY 305 Microcomputers in Business is required. Course work must be taken either during the first semester or summer session of the student's matriculation and completed with a grade of B or better.

Proficiency in Writing: The MBA program requires the ability to think clearly and write effectively. If a score of "4" or more on the Graduate Management Admission Test (GMAT) Analytical Writing Assessment is not achieved, students will need to satisfy this requirement through course work in college-level English and/or other remedial work. This requirement must be satisfied during either the first semester or summer session of the student's matriculation and completed with a grade of B or better.

Prerequisite Business Core Requirement (18 credits): The business prerequisite "core" provides a foundation in theory, tools and techniques required for competent legal and ethical management of profit and/or nonprofit organizations. The prerequisites also provide a basic understanding of the concepts and applications of financial reporting, domestic and global economic environments of organizations, creation and distribution of goods and services and human behavior in organizations.

For holders of an undergraduate degree in a business field from an accredited college-level business program, the 18 credits of required "core" is met if the relevant undergraduate course work in the undergraduate degree program was completed with a grade of B or better in each course within seven years prior to admission to the MBA program. Course work not meeting these tests of relevancy, grade, or currency must be taken at the graduate level as a prerequisite prior to starting course work in the 30-credit MBA program.

An applicant holding a baccalaureate degree in a non-business field from an accredited, college-level institution may satisfy a core requirement through completion of a minimum of 6 credits of advanced undergraduate work in a single area of concentration completed with a grade of B or better within seven years prior to admission to the MBA program (e.g., BUS 501 Statistical Analysis for Business Decisions might be met by holders of an undergraduate degree in statistics) or through credits earned in an equivalent graduate-level program at an accredited college-level institution with a grade of B or better within seven years prior to admission to the MBA program. Course work not meeting these tests of relevancy, grade, or currency must be taken at the graduate level as a prerequisite prior to starting course work in the 30-credit MBA program.

PREREQUISITE COURSES: 18 credits

BUS 501; ECNMS 510; MNGMT 510, 522; MRKT 520; P ACC 501

Degree Requirements

In addition to the mathematics, computer, and writing proficiency requirements and the prerequisite courses, the M.B.A. degree requires 30 credits of course work at the graduate level (500-level or higher). These are distributed over two groups of courses: Breadth and Electives.

BREADTH COURSES: 18 credits, aimed at developing general competence for overall management
BUS 584, 588; FINAN 521; INFSY 540; P ACC 540; either BUS 550 and 551 or BUS 554.

ELECTIVE COURSES: 12 credits

Electives allow students to select additional courses of interest. Six credits of elective courses must be taken from courses offered by the School of Business Administration. Other electives may be selected from courses offered by the School of Business Administration and/or courses offered by other academic programs. Electives must be selected in consultation with a faculty adviser and have prior MBA approval.

Transfer Credit and Course Substitutions

Transfer Credits: Up to 10 transfer credits may be applied toward the degree. However, credits used to complete a previous degree may not be applied. These courses must have been completed within the past five years, appear on a graduate transcript, and have been passed with a B grade or better earned in an equivalent graduate-level program at an accredited, college-level institution. It must be the opinion of the reviewing faculty that these courses are equivalent in quality to those offered at Penn State Harrisburg. Credit will not be given for any course used to complete a previous graduate degree.

Course substitutions: Except for BUS 588, which must be taken at Penn State Harrisburg, up to 6 credits of Breadth courses may be replaced with more advanced courses in the same field. Substitutions are based on a minimum of 6 credits of advanced undergraduate course work in an area of concentration or credits earned in an equivalent graduate-level program at an accredited, college-level institution. These courses must have been completed within the past five years and have earned a grade of B or better. Substituted courses must be replaced with other advanced graduate courses in the same field for which the substitute is an important foundation/prerequisite. Students will be informed of this in a letter received from the program office. Substitutions are based on past academic performance. An examination cannot be used for earned graduate course credit.

Grade-point Average and Time Limit

A 3.00 (out of 4.00) minimum grade-point average is required before a student is awarded an M.B.A. degree. All course work must be completed within six years, or seven consecutive summers of matriculation.

Financial aid

There are a limited number of scholarships, fellowships, and research grants available, as well as several graduate assistantships. For more information on these, contact the School of Business Administration.

Many students work full-time and take classes part-time. In many cases, employers have a tuition-reimbursement plan paying for partial or full tuition. To find other options available to you, contact one of the following offices: Financial Aid Office, (717) 948-6307; Enrollment Services, (717) 948-6250.

COURSES

BUSINESS (BUS)

501. STATISTICAL ANALYSIS FOR BUSINESS DECISIONS (3) Application of statistical techniques to the formulation, analysis, interpretation, and solution of business problems. Prerequisite: admission to MBA or MS/IS program.

520. ADMINISTRATIVE MODELS (3) Formulation and solution of decision models for administrative problems. Analysis of decision making under certainty, risk, and uncertainty. Prerequisite: BUS 548.

548. QUANTITATIVE METHODS (3) Advanced topics in quantitative analysis including game theory, integer and dynamic programming, waiting line models, Markov process and simulation. Prerequisite: MNGMT 522.

550. BUSINESS RESEARCH METHODS (1) Selection of a research topic, construction of a bibliography, literature survey and data collection, and preparation of a research proposal. Prerequisite: This course must be completed successfully (grade of A, B, or C) before registering for the last 6 credits of the M.B.A. program. Concurrent: BUS 551.

551. MASTER'S PAPER (2) Completion of a professional paper in the student's major field of interest under supervision of a faculty member. Prerequisite: This course must be completed successfully (grade of A, B, or C) before registering for the last 6 credits of the M.B.A. program. Concurrent: BUS 550.

552. MULTIVARIATE ANALYSIS FOR BUSINESS (3) Application of multivariate statistical methods for analyzing the relationships between two or more variables. Prerequisite: BUS 501.

554. MASTER'S PROJECT (3) Development of an original master's project in the student's professional field of interest and preparation of a paper. Prerequisite: This course must be completed successfully (grade of A, B, or C) before registering for the last 6 credits of the MBA program.

556. ECONOMIC AND BUSINESS FORECASTING (3) Application and evaluation of methods for forecasting regional economic change and business activity. Prerequisites: BUS 501, ECNMS 510.

584. BUSINESS IN A GLOBAL SOCIETY (3) Business sector and society relations; international and cultural issues; corporate values and ethics; relationship to stakeholders; social, political, legal environments. Prerequisite: admission to MBA or MS/IS program.

588. STRATEGIC MANAGEMENT (3) Analysis of administrative problems from a total organization viewpoint. Case studies of actual organizations are used for analysis. Prerequisite: all course work or permission of the program.

589. SMALL BUSINESS MANAGEMENT PRACTICUM (1-3) Advanced study and practice in small business management through field assignments with cooperating firms to analyze and solve managerial problems.

590. COLLOQUIUM (1-3)

595. INTERNSHIP (1-18)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

ECONOMICS (ECNMS)

510. MANAGERIAL ECONOMICS (3) Economic analysis of demand for the firm's output and production costs; implications of various market structures; government regulation. Prerequisite: admission to the M.B.A. or M.S.I.S. program.

560. MACROECONOMIC ANALYSIS (3) Macroeconomic theory; international trade and finance; monetary and fiscal policies and their effects on the firm. Prerequisite: ECNMS 510.

FINANCE (FINAN)

518. FINANCIAL MARKETS AND THE ECONOMY (3) Operation, regulation, use, and evaluation of principal financial markets and institutions; monetary policy, asset pricing, and their effects on business. Prerequisite: ECNMS 510.

521. CORPORATE FINANCE (3) An in-depth analysis of concepts and techniques of corporate financial management. Prerequisites: P ACC 501.

522. INVESTMENT AND PORTFOLIO MANAGEMENT (3) Investment analysis and portfolio management theory and applications. Prerequisite: FINAN 521.

526. INTERNATIONAL FINANCE (3) Basics of corporate finance extended to the international environment through a special consideration of exchange rate behavior and its management. Prerequisite: FINAN 521.

530. FINANCIAL MANAGEMENT (3) An in-depth examination of techniques and models of financial decision making in a business environment. Prerequisite: FINAN 521.

531. MANAGING FINANCIAL OPERATIONS (3) A course for financial managers; working capital management; financial planning, financial controls, reporting, financial strategies; theory and practice. Prerequisite: FINAN 521.

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

INFORMATION SYSTEMS (INFSY)

540. INFORMATION RESOURCES MANAGEMENT (3) Information systems analysis, design, application, operation, and management; methods for integrating information resources into a decision support framework. Prerequisite: graduate standing. Prerequisite: graduate standing.

545. PROGRAM, DATA, AND FILE STRUCTURES (3) Program, data, and file structures are studied as they relate to management of data in information systems. Prerequisite: acceptance into MSIS program or permission of program.

550. STRATEGIC INFORMATION SYSTEMS (3) Comprehensive coverage of concepts, applications, and management of strategic information systems in organizations. Prerequisite: INFSY 540.

554. MASTER'S PROJECT (3) Development of an original master's project in the student's field of interest and preparation of a paper. Prerequisite: last 6 credits of MS/IS program.

555. DATA MANAGEMENT SYSTEMS (3) Concepts and theory of database management systems explored through data modeling and planning techniques. Prerequisite: acceptance into MSIS program or permission of program.

560. DATA COMMUNICATIONS SYSTEMS AND NETWORKS (3) Hardware and software concepts relevant to current communications and networking technology. The importance of telecommunications is emphasized. Prerequisite: INFSY 540.

565. EXPERT SYSTEMS TECHNOLOGY MANAGEMENT (3) Expert systems and decision support with emphasis on managerial applications and the support of the decision making process. Prerequisites: graduate standing; 6 credits of programming.

570. SOFTWARE ENGINEERING IN THE ANALYSIS AND DESIGN OF INFORMATION SYSTEMS (3) Software engineering concepts, specifically the analysis and design of structured information systems using computer-aided software engineering (CASE). Prerequisite: acceptance into MSIS program or permission of program.

575. SEMINAR IN INFORMATION TECHNOLOGY MANAGEMENT (3) Examination of selected topics relevant to current and future managerial and organizational issues of information technology. Prerequisite: INFSY 555 or 570.

587. GLOBAL INFORMATION TECHNOLOGY (3) Comprehensive coverage of components, applications, and issues of global information technology management in organizations worldwide. Prerequisite: INFSY 555 or 570.

595. INTERNSHIP (1–18)

596. INDIVIDUAL STUDIES (3)

597. SPECIAL TOPICS (3)

MANAGEMENT (MNGMT)

505. PERSONNEL MANAGEMENT (3) Problems in effectively selecting, utilizing, and developing human resources from the viewpoint of the total organization—both private and public. Prerequisite: admission to MBA or MS/IS program.

510. ORGANIZATIONAL BEHAVIOR (3) Examination of concepts of human behavior in formal organizations, systems analysis, conceptual models, and decision processes. Prerequisite: admission to graduate degree candidacy.

512. ADMINISTRATIVE THEORY (3) Advanced analysis of selected areas of administrative theory and research, with special emphasis on application to current organizational problems. Prerequisite: MNGMT 510.

515. LABOR MANAGEMENT RELATIONS (3) Labor relations issues; collective bargaining agreement, negotiations, and administration; legal framework of collective bargaining; labor relations in larger social context. Prerequisite: admission to graduate degree candidacy.

520. ORGANIZATIONAL TRANSFORMATION (3) Treats methods, practices, and theory of organizational empowerment, quality management, process redesign, reengineering, restructuring, and planned change. Prerequisite: MNGMT 510.

522. OPERATIONS MANAGEMENT (3) Integration and application of decision making to operational and policy problems within the business firm. Prerequisite: ECNMS 510.

560. MANUFACTURING METHODS (3) Survey of manufacturing technologies and management techniques for controlling production systems. Prerequisite: MNGMT 522.

565. PROJECT MANAGEMENT (3) Examines the behavioral and quantitative aspects of managing in the project environment. Prerequisite: MNGMT 522.

576. MANAGING FOR TOTAL QUALITY (3) Treats methods and techniques of modern quality improvement, including change management, empowerment, leadership. Prerequisite: MNGMT 510.

596. INDIVIDUAL STUDIES (1–9)

597. SPECIAL TOPICS (1–9)

MARKETING (MRKT)

520. MARKETING MANAGEMENT (3) Consideration of modern marketing concepts, application, and managerial issues. Prerequisites: BUS 501, ECNMS 510.

570. MARKETING STRATEGY AND PLANNING (3) Analysis of management's marketing problems, including marketing analyses, pricing, channels of distribution, promotion, competition, product strategies, and marketing research. Prerequisite: MRKT 520.

571. CONSUMER BEHAVIOR (3) Factors influencing buyer behavior; contributions of the behavioral sciences to the study of selected phenomena. Prerequisite: MRKT 520.

572. MARKETING RESEARCH (3) Management information needs, evaluation of research proposals and findings, methods of data collection and analysis, integration of research and decisions. Prerequisite: MRKT 520.

585. BUSINESS-TO-BUSINESS MARKETING (3) Marketing of products and services to other businesses and organizations, including strategy, planning, research, communications, pricing, distribution, and global issues. Prerequisite: MRKT 520.

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

PROFESSIONAL ACCOUNTANCY (P ACC)

501. FINANCIAL STATEMENT ANALYSIS (3) Study of financial reporting, financial statement analysis, capital markets, asset pricing and impact of ethical, legal, regulatory, and environmental concerns. Prerequisite: admission to the M.B.A. or M.S.I.S. program.

540. MANAGERIAL ACCOUNTING (3) Accounting concepts and issues from a managerial perspective. Prerequisite: P ACC 501.

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

CELL AND MOLECULAR BIOLOGY (CMBIO)

BRIAN WIGDAHL, *Director of the Cell and Molecular Biology Graduate Program*

The Milton S. Hershey Medical Center

Hershey, PA 17033

717-531-6608

Degrees Conferred: Ph.D., M.S.

The Graduate Faculty

David A. Antonetti, Ph.D. (Penn State) *Assistant Professor of Cellular and Molecular Physiology*

Kenneth M. Baker, M.D. (Temple) *Professor of Cellular and Molecular Physiology and Medicine*

V. P. Bhavanandan, Ph.D. (Edinburgh) *Professor of Biochemistry and Molecular Biology*

Melvin L. Billingsley, Ph.D. (George Washington) *Professor of Pharmacology*

Judith S. Bond, Ph.D. (Rutgers) *Professor and Chair of Biochemistry and Molecular Biology*

David J. Carey, Ph.D. (St. Louis) *Professor of Cellular and Molecular Biology*

Keith C. Cheng, M.D., Ph.D. (New York/NYU) *Assistant Professor of Biochemistry and Molecular Biology, and Pathology*

Joseph Y. Cheung, M.D., Ph.D. (Duke/Penn State) *Professor of Medicine, and Cellular and Molecular Physiology*

Michael J. Chorney, Ph.D. (Cornell) *Associate Professor of Microbiology and Immunology and Pediatrics*

Gary A. Clawson, M.D., Ph.D. (Miami/Michigan State) *Professor of Pathology, and Biochemistry and Molecular Biology*

James R. Connor, Ph.D. (California, Berkeley) *Professor of Neuroscience and Anatomy*

Richard J. Courtney, Ph.D. (Syracuse) *Professor and Chair of Microbiology and Immunology*

Rebecca C. Craven, Ph.D. (Tennessee) *Assistant Professor of Microbiology and Immunology*

Zahi Damuni, Ph.D. (Dundee, Scotland) *Associate Professor of Cellular and Molecular Physiology*

Henry J. Donahue, Ph.D. (California, Santa Barbara) *Associate Professor of Orthopaedics and Rehabilitation, and Cellular and Molecular Physiology*

Kristin A. Eckert, Ph.D. (Wisconsin) *Assistant Professor of Pathology, and Biochemistry and Molecular Biology*

Joanna Floros, Ph.D. (Temple) *Professor of Cellular and Molecular Biology and Pediatrics*

Michael G. Fried, Ph.D. (Yale) *Associate Professor of Biochemistry and Molecular Biology*

Thomas Friele, Ph.D. (Pittsburgh, School of Medicine) *Assistant Professor of Pharmacology*

Ellen J. Hess, Ph.D. (UCSD) *Assistant Professor of Neuroscience and Anatomy*

James M. Hammond, M.D. (Washington, St. Louis) *Professor of Medicine and Cellular and Molecular Physiology*

Ellen J. Hess, Ph.D. (California, San Diego) *Assistant Professor of Neuroscience and Anatomy*

Charles W. Hill, Ph.D. (Wisconsin) *Professor of Biochemistry and Molecular Biology*

Anita K. Hopper, Ph.D. (Illinois) *Professor of Biochemistry and Molecular Biology*

James E. Hopper, Ph.D. (Wisconsin) *Professor of Biochemistry and Molecular Biology*

Mary K. Howett, Ph.D. (Pennsylvania) *Professor of Microbiology and Immunology*
 Harriet C. Isom, Ph.D. (Illinois) *Professor of Microbiology and Immunology and Pathology*
 Leonard S. Jefferson, Ph.D. (Vanderbilt) *Professor and Chair of Cellular and Molecular Physiology*
 Sebastian Joyce, Ph.D. (Virginia Commonwealth) *Assistant Professor of Microbiology and Immunology*
 Michael Katzman, M.D. (Columbia) *Assistant Professor of Medicine and Microbiology and Immunology*
 Ralph L. Keil, Ph.D. (Cornell) *Assistant Professor of Biochemistry and Molecular Biology*
 Mark Kester, Ph.D. (SUNY at Buffalo) *Associate Professor of Pharmacology*
 Charles H. Lang, Ph.D. (Hahnemann) *Professor of Cellular and Molecular Physiology and Surgery*
 Kathryn F. LaNoue, Ph.D. (Yale) *Professor of Cellular and Molecular Physiology*
 Robert Levenson, Ph.D. (SUNY, Stony Brook) *Professor of Pharmacology*
 Steven W. Levison, Ph.D. (North Carolina, Chapel Hill) *Assistant Professor of Neuroscience and Anatomy*
 Erich Lieth, Ph.D. (North Carolina, Chapel Hill) *Assistant Professor of Neuroscience and Anatomy*
 Christopher J. Lynch, Ph.D. (Northeastern) *Associate Professor of Cellular and Molecular Physiology*
 William A. Maltese, Ph.D. (Syracuse) *Professor of Cellular and Molecular Physiology*
 Jan M. McAllister, Ph.D. (UCSD) *Assistant Professor of Cellular and Molecular Physiology*
 Patricia J. McLaughlin, D.Ed. (Penn State) *Assistant Professor of Neuroscience and Anatomy*
 Craig Meyers, Ph.D. (California, Los Angeles) *Assistant Professor of Microbiology and Immunology*
 Kathleen M. Mulder, Ph.D. (SUNY at Buffalo) *Associate Professor of Pharmacology*
 Yuk-Chow Ng, Ph.D. (Michigan) *Assistant Professor of Pharmacology*
 Stephen A. Osmani, Ph.D. (Kings College, London) *Professor of Cellular and Molecular Physiology*
 Anthony E. Pegg, Ph.D. (Cambridge) *Evan Pugh Professor of Cellular and Molecular Physiology, and Pharmacology; J. Lloyd Huck Professor of Cell and Molecular Biology*
 David S. Phelps, Ph.D. (Temple) *Associate Professor of Pediatrics*
 Patrick G. Quinn, Ph.D. (Michigan) *Associate Professor of Cellular and Molecular Physiology*
 D. Eugene Rannels, Ph.D. (Penn State) *Distinguished Professor of Cellular and Molecular Physiology*
 Stephen R. Rannels, Ph.D. (Penn State) *Associate Professor of Cellular and Molecular Physiology*
 Janet D. Robishaw, Ph.D. (Penn State) *Professor of Cellular and Molecular Physiology*
 Ira J. Ropson, Ph.D. (Johns Hopkins) *Assistant Professor of Biochemistry and Molecular Biology*
 Lawrence I. Rothblum, Ph.D. (Hahnemann) *Professor of Cellular and Molecular Biology*
 Cara-Lynne Schengrund, Ph.D. (Seton Hall) *Professor of Biochemistry and Molecular Biology*
 Ross Shiman, Ph.D. (California) *Professor of Biochemistry and Molecular Biology*
 David J. Spector, Ph.D. (Pennsylvania) *Associate Professor of Microbiology and Immunology*
 Shao-Cong Sun, Ph.D. (Stockholm, Sweden) *Assistant Professor of Microbiology and Immunology*
 Mary Judith Tevethia, Ph.D. (Michigan State) *Professor of Microbiology and Immunology*
 Satvir S. Tevethia, Ph.D. (Michigan State) *Professor of Microbiology and Immunology*
 Thomas C. Vary, Ph.D. (Penn State) *Professor of Cellular and Molecular Physiology*
 Michael F. Verderame, Ph.D. (Columbia) *Assistant Professor of Microbiology and Immunology*
 Keith Verner, Ph.D. (Cornell) *Associate Professor of Cellular and Molecular Physiology*
 Danny R. Welch, Ph.D. (Texas-Houston) *Associate Professor of Pathology*
 Brian Wigdahl, Ph.D. (Medical College of Wisconsin) *Professor of Microbiology and Immunology*
 John W. Wills, Ph.D. (Tennessee) *Professor of Microbiology and Immunology*
 Teresa L. Wood, Ph.D. (California, Los Angeles) *Assistant Professor of Neuroscience and Anatomy*
 Ian S. Zagon, Ph.D. (Colorado) *Professor of Neuroscience and Anatomy*

The Cell and Molecular Biology graduate program is an interdepartmental program within the College of Medicine that is designed to enable students to take an integrated series of courses leading to the Ph.D. degree. The program encompasses both the fundamentals of cell and molecular biology and advanced laboratory training in a specialized area. All courses are available at the College of Medicine.

Faculty in this program and positioned at the Siegfried and Janet Weis Center for Research are competent to prepare students in almost all subfields of cell and molecular biology, including membrane structure, receptors, and modulators; the role of extracellular matrix in cellular function; organelle assembly, structure, and function; cell division, differentiation, adhesion, communication, and movement; recombination, organization, and expression of genes; gene mapping and recombinant DNA; and regulation of gene expression. Modern, well-equipped laboratories are available for graduate students from the molecular to tissue level.

Molecular Medicine Option

The Molecular Medicine option within the Cell and Molecular Biology graduate program represents a new and exciting alternative course of study within the program that is designed to use innovative approaches

to train highly qualified scientists who will enter professional careers not only with strong grounding in the basic sciences, but also with an understanding of the pathophysiological basis of human disease and its treatment. Training faculty and students will be involved in curriculum and research activities that encompass concepts from the most molecular aspects of nucleic acid and protein structure to the physiology of cell and organ function. Graduates will enter careers that impact human health and strategies to prevent and treat disease. Research will center on four areas of investigation: cancer; metabolic regulation; infectious disease; and molecular and human genetics. The unique aspects of Molecular Medicine include: (1) a core course sequence that facilitates interaction of Molecular Medicine students with M.D./Ph.D. students and students in all other College of Medicine graduate programs; (2) a basic/clinical problem-solving track; (3) involvement of multidisciplinary research groups in the four main areas of investigation; (4) dual basic/clinical science mentorship; and (5) opportunities for internships in industry and government.

Admission Requirements

Qualified students with undergraduate preparation in either the biological, biochemical, or physical sciences and an overall grade-point average of 3.00 or better will be considered for admission. The best-qualified applicants will be accepted on a space-available basis. Applications must include transcripts, three letters of recommendation, Graduate Record Examination scores (or scores from a comparable examination accepted by the graduate program, e.g., MCAT exam), and a brief personal essay summarizing the background and professional goals of the applicant. The M.S. degree may be sought as part of the doctoral program.

Doctoral Degree Requirements

The formal course requirements depend upon the individual student's career goals. Each student will be required to complete the following successfully: (1) A candidacy examination covering the general course material that will consist of a written portion to test factual knowledge and an oral portion to examine research potential. The examination will be given after completion of the spring semester of the first year. (2) A communications requirement to be completed after the candidacy examination. (3) A comprehensive examination consisting of a written research proposal and an oral defense of that proposal will be required after completion of the spring semester of the second year. (4) An original research project under the supervision of a Cell and Molecular Biology faculty adviser. (5) A thesis. (6) A final oral defense of the thesis. The program is designed for completion within four years, but this can vary depending on the individual progress of the student.

Student Aid

Graduate Assistantships and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*. Graduate assistantships in the program are awarded by the Cell and Molecular Biology Program Committee. After the second year, Cell and Molecular Biology students are eligible for departmental teaching or research assistantships and other assistantships supported by grant funds of individual faculty members. The program encourages all Ph.D. candidates to apply for fellowships, scholarships, and stipend support from outside sources. For students obtaining outside fellowships, scholarships, and stipend support, supplementation to the level of the assistantships will be provided.

CELL AND MOLECULAR BIOLOGY (CMBIO)

503. (BCHEM, MICRO) MOLECULAR BIOLOGY (3) Principles of molecular and microbial genetics; emphasis placed on experimental design toward problems in bacteria and lower eukaryotes. Prerequisite: BCHEM 502.

513. (BCHEM) PRINCIPLES OF PROTEIN STRUCTURE (3) Review of thermodynamics; physical chemistry and architecture of globular proteins; predictive approaches; laboratory in computer modeling of three-dimensional structure.

520. (BCHEM) GENETIC ANALYSIS (3) Genetics of organisms most used in the analysis of problems in molecular biology; drosophila, yeast, and bacteria.

530. (PSIO) METABOLIC AND ENDOCRINE PHYSIOLOGY (3) Regulation of carbohydrates, fatty acid, and protein metabolism; regulation of hormone secretion; effects of hormones on water and cell metabolism.

540. (PSIO) CELL BIOLOGY (3) Lectures in cell biology, including membrane, cytoskeleton, and organelle structure and function; cell division, differentiation, adhesion, communication, and movement. Prerequisite: BCHEM 502.

541. (PHARM) CELLULAR COMMUNICATION (2) This course explores the cellular and molecular basis of signal generation and information transduction in cells. Prerequisites: BCHEM 502, 505, CMBIO 540.
551. (BCHEM) KINETICS AND CATALYSIS IN BIOCHEMICAL SYSTEMS (3) Information obtainable from steady-state and transient kinetic measurement on enzymes and cellular processes, Molecular basis for enzyme specificity and catalysis. Prerequisite: BCHEM 502.
553. (MICRO) SCIENCE OF VIROLOGY (3) Emphasizes replication of viruses and effect on host, including transfer of genetic information, immunology, and oncogenic properties of viruses.
560. (MICRO) CONCEPTS IN IMMUNOLOGY (3) Lectures in advanced immunology, including T and B cell function, receptors, gene rearrangements, and synthetic vaccines.
590. COLLOQUIUM (1-3)
594. RESEARCH TOPICS (1-8)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)
- 597A. SPECIAL TOPICS: MOLECULAR BASIS OF HUMAN DISEASE (2)

CHEMICAL ENGINEERING (CH E)

J. LARRY DUDA, *Head of the Department*
160 Fenske Laboratory
814-865-2574

Degrees Conferred: Ph.D., M.S.

The Graduate Faculty

Ali Borhan, Ph.D. (Stanford) *Assistant Professor of Chemical Engineering*
Alfred Carlson, Ph.D. (Wisconsin) *Assistant Professor of Chemical Engineering*
Lance Collins, Ph.D. (Pennsylvania) *Associate Professor of Chemical Engineering*
Wayne R. Curtis, Ph.D. (Purdue) *Assistant Professor of Chemical Engineering and Biotechnology*
Ronald P. Danner, Ph.D. (Lehigh) *Professor of Chemical Engineering*
Thomas E. Daubert, Ph.D. (Penn State) *Professor of Chemical Engineering*
J. Larry Duda, Ph.D. (Delaware) *Professor of Chemical Engineering*
David Edwards (Illinois Inst. of Tech.) *Associate Professor of Chemical Engineering*
Kristen Fichthorn, Ph.D. (Michigan) *Associate Professor of Chemical Engineering*
Costas D. Maranas (Princeton) *Assistant Professor of Chemical Engineering*
Themis Matsoukas, Ph.D. (Michigan) *Assistant Professor of Chemical Engineering*
John R. McWhirter, Ph.D. (Penn State) *Professor of Chemical Engineering*
Ramanathan Nagarajan, Ph.D. (SUNY, Buffalo) *Professor of Chemical Engineering*
Jonathan Phillips, Ph.D. (Wisconsin) *Professor of Chemical Engineering*
John W. Tarbell, Ph.D. (Delaware) *Professor of Chemical Engineering*
James S. Ultman, Ph.D. (Delaware) *Professor Chemical Engineering*
M. Albert Vannice, Ph.D. (Stanford) *Professor of Chemical Engineering*
Darrell Velegol (Carnegie Mellon) *Assistant Professor of Chemical Engineering*
James S. Vrentas, Ph.D. (Delaware) *Professor of Chemical Engineering*

Course offerings or research facilities are available in the following areas: applied thermodynamics, physiological transport studies, biotechnology, catalysis and surface science, polymer and colloid science, transport phenomena, tribology and lubrication.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

To be admitted, a student should be a graduate of an accredited major in chemical engineering or the equivalent. Graduates of other accredited engineering or physical science majors may be admitted but will be required to make up certain undergraduate deficiencies without graduate credit. Students with a 3.00 junior/senior average (on a 4.00 scale) and with appropriate course backgrounds will be considered for

admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students.

Master's Degree Requirements

A minimum of 18 course credits is required and must include at least 12 credits in the 500-series chemical engineering courses. A thesis is required. There is no communication or language requirement.

Continuous registration is required for all graduate students until the thesis is approved.

Doctoral Degree Requirements

A minimum of 30 graduate course credits is required and must include a minimum of 15 credits of 500-series Chemical Engineering courses taken at the University. There is no communication or language requirement. The comprehensive examination consists of a written research proposal or project defended orally after it has been accepted.

Continuous registration is required for all graduate students until the thesis is approved.

Other Relevant Information

An option for specialization in Biomolecular Transport Dynamics is available to doctoral students. This option provides interdisciplinary education in biotransport phenomena, molecular and cell biology, and medical applications.

Programs leading to a minor in Chemical Engineering are available to both M.S. and Ph.D. candidates who wish to complement studies in their major fields with a broader knowledge of chemical thermodynamics, transport phenomena, and reactor design.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

CHEMICAL ENGINEERING (CH E)

- 401. CHEMICAL PROCESS ENGINEERING (3)
- 407. CHEMICAL ENGINEERING LABORATORY (3)
- 413. MASS TRANSFER OPERATIONS (3)
- 414. KINETICS AND INDUSTRIAL CHEMISTRY (3)
- 415. MATHEMATICAL MODELING IN CHEMICAL ENGINEERING (3)
- 420. CRYOGENIC ENGINEERING (3)
- 432. (F SC) PETROLEUM PROCESSING (3)
- 435. INDUSTRIAL ORGANIC CHEMISTRY (3)
- 438. BIOPROCESS ENGINEERING (3)
- 441. POLYMER PROCESSING (3)
- 446. INTRODUCTION TO TRANSPORT PHENOMENA (3)
- 448. ADVANCED MASS TRANSFER OPERATIONS (3)
- 450. PROCESS DYNAMICS AND CONTROL (3)
- 453. THERMODYNAMICS FOR CHEMICAL ENGINEERS (3)
- 455. CHEMICAL REACTOR DESIGN (3)
- 464. DESIGN OF CHEMICAL PLANTS (3)
- 465. DESIGN PROJECTS IN CHEMICAL ENGINEERING (1-6)
- 494. RESEARCH PROJECTS IN CHEMICAL ENGINEERING (1-6)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

501. (BIOE) BIOENGINEERING TRANSPORT PHENOMENA (3) Application of the equations of mass, energy, and momentum conservation to physiological phenomena and to the design of artificial organs.

503. (BIOE) FLUID MECHANICS OF BIOENGINEERING SYSTEMS (3) Cardiovascular system and blood flow, non-Newtonian fluid description, vessel flows, unsteady flows and wave motion, windkessel theory, transmission line theory.

516. METHODS OF PROCESS DESIGN (3) Survey of mathematical techniques of chemical process design, with emphasis on economic choice and optimal decision making.

524. CHEMICAL ENGINEERING, APPLICATION OF THERMODYNAMICS (3) Elements of thermochemistry and thermodynamics of greatest importance in chemical engineering.

528. COLLOIDAL FORCES AND THERMODYNAMICS (3) Unified treatment of formation, growth, and stability of colloids based on principles of intermolecular and colloidal forces and thermodynamics. Prerequisite: CHEM 451, CH E 304 or an equivalent background in chemical thermodynamics.
535. CHEMICAL REACTION ENGINEERING (3) Optimal design of batch and continuous chemical reactors and reactor batteries; effect of mixing on reactor operation.
536. HETEROGENEOUS CATALYSIS (3) Thermodynamics and kinetics of adsorption and reactions and solid surfaces, heat and mass transfer effects, theory and correlations in catalysis. Prerequisites: CHEM 451, 452.
544. GENERAL TRANSPORT PHENOMENA (3) Formulation and solution of transport problems involving momentum, heat, and mass transfer, with chemical engineering applications. Prerequisites: CH E 302, 413.
545. TRANSPORT PHENOMENA I (3) Momentum transport, laminar and turbulent flow, boundary layer analysis, non-Newtonian flow, mechanical energy balance, chemical engineering application.
546. TRANSPORT PHENOMENA II (3) Heat and mass transfer, steady and unsteady state, coupling, molecular diffusion, moving boundaries, transfer coefficients, chemical engineering applications.
550. DYNAMICS OF CHEMICAL SYSTEMS (3) Systems models; steady-state multiplicity; linear and nonlinear stability; oscillatory and chaotic states; multivariable and optimal; nonequilibrium thermodynamic stability. Prerequisite: CH E 450.
590. COLLOQUIUM (1)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

CHEMISTRY (CHEM)

PETER C. JURS, *Acting Head of the Department*
152 Davey Laboratory
814-865-6553

Degrees Conferred: Ph.D., M.S.

The Graduate Faculty

David L. Allara, Ph.D. (UCLA) *Professor of Materials Science and Chemistry*
Harry R. Allcock, Ph.D. (London) *Evan Pugh Professor of Chemistry*
James B. Anderson, Ph.D. (Princeton) *Evan Pugh Professor of Chemistry*
Anne M. Andrews, Ph.D. (American University) *Assistant Professor of Chemistry*
John V. Badding, Ph.D. (California, Berkeley) *Associate Professor of Chemistry*
Alan J. Benesi, Ph.D. (California, Berkeley) *Lecturer in Chemistry*
Stephen J. Benkovic, Ph.D. (Cornell) *Evan Pugh Professor and Eberly Chair in Chemistry*
Philip C. Bevilacqua, Ph.D. (Univ. of Rochester) *Assistant Professor of Chemistry*
A. Welford Castleman, Ph.D. (Polytechnic Institute of Brooklyn) *Evan Pugh Professor of Chemistry*
John R. Desjarlais, Ph.D. (Johns Hopkins) *Assistant Professor of Chemistry*
Wolfgang E. Ernst, D.rer.Nat. (Hannover) *Professor of Physics and Adjunct Professor of Chemistry*
Andrew G. Ewing, Ph.D. (Indiana U.) *Professor of Chemistry*
Kenneth S. Feldman, Ph.D. (Stanford U.) *Professor of Chemistry*
Raymond L. Funk, Ph.D. (California) *Professor of Chemistry*
Barbara J. Garrison, Ph.D. (California, Berkeley) *Professor of Chemistry*
Timothy E. Glass, Ph.D. (Stanford) *Assistant Professor of Chemistry*
L. Peter Gold, Ph.D. (Harvard) *Professor of Chemistry*
William DeW. Horrocks, Jr., Ph.D. (MIT) *Professor of Chemistry*
Peter C. Jurs, Ph.D. (Washington) *Professor of Chemistry*
Juliette T. J. Lecomte, Ph.D. (Carnegie Mellon) *Associate Professor of Chemistry*
John P. Lowe, Ph.D. (Northwestern) *Professor of Chemistry*
Thomas E. Mallouk, Ph.D. (California, Berkeley) *Professor of Chemistry*
Mark Maroncelli, Ph.D. (California, Berkeley) *Professor of Chemistry*
Przemyslaw Maslak, Ph.D. (Kentucky) *Associate Professor of Chemistry*
C. Robert Matthews, Ph.D. (Northwestern) *Professor of Chemistry and Eberly Family Professor of Biotechnology*
Kenneth M. Merz, Ph.D. (Texas) *Professor of Chemistry*

Robert D. Minard, Ph.D. (Cornell) *Senior Lecturer in Chemistry*

Karl T. Mueller, Ph.D. (California, Berkeley) *Assistant Professor of Chemistry*

Michael J. Natan, Ph.D. (MIT) *Associate Professor of Chemistry*

Blake R. Peterson, Ph.D. (UCLA) *Assistant Professor of Chemistry*

Ayusman Sen, Ph.D. (Chicago) *Professor of Chemistry*

Steven M. Weinreb, Ph.D. (Rochester) *Russell and Mildred Marker Professor of Natural Products Chemistry*

Paul S. Weiss, Ph.D. (California, Berkeley) *Associate Professor of Chemistry*

Nicholas Winograd, Ph.D. (Case Western Reserve) *Evan Pugh Professor of Chemistry*

Xumu Zhang, Ph.D. (Stanford) *Assistant Professor of Chemistry*

The Ph.D. program in Chemistry provides students with a broad background in chemistry and intensive research experience culminating in the preparation of a formal thesis. The goal of the program is to prepare students for a variety of careers in academia, government, or industry. The exceptionally high quality of our laboratory and computer facilities enables us to provide students with outstanding research opportunities. Distinguished visiting scholars conduct informal discussions each week at a departmental colloquium.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are required for admission. In extenuating circumstances, a student may be admitted provisionally for graduate study in the program without these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

For admission, at least integral calculus plus one year's work in general physics, organic chemistry, physical chemistry, and either analytical or inorganic chemistry are normally required. Students who have appropriate course backgrounds and who present a 2.50 average (on a 4.00 scale) in all undergraduate courses in chemistry, physics, and mathematics will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

Master's Degree Requirements

The program of the M.S. candidate must include a total of at least 30 graduate-level course credits (CHEM 431, 451, 452, 457, 458, 489, and 500 may not be included in this credit count.)

Additional requirements of the M.S. program are that the candidate must write either a thesis or research report and must defend this thesis or report at an oral examination. The thesis or report will be accomplished under the sponsorship of a faculty member, and the candidate must schedule at least 6 credits of CHEM 600 (for a thesis) or CHEM 589 (for a research report) to fulfill this requirement. The candidate's attainments under a thesis or research report must be approved by a committee of at least three faculty members, one of whom will be the candidate's sponsor.

Qualifying examinations in analytical, biological, inorganic, organic, and physical chemistry will be given to all new students upon entrance in the fall semester. These exams cover subject matter at the level of the basic courses offered for the B.S. degree in chemistry at Penn State. For certification as an M.S. candidate, proficiency in two areas is required. These must include physical chemistry. Such proficiency may be demonstrated either by (1) passing the area examination upon entrance, or (2) obtaining a grade-point equivalent of 3.0 in at least 3 credits of graduate-level course work in the area. The courses to be used to fulfill this latter option will be designated by the graduate counseling committee. This course work must be completed successfully during the student's first two semesters of residence.

A final oral examination will be administered by a committee consisting of the student's research preceptor and two other faculty members. This examination is scheduled after the M.S. thesis or research report has been completed.

Doctoral Degree Requirements

Candidates for the Ph.D. degree in Chemistry must meet the following requirements established by the department faculty.

A Ph.D. candidate shall be required to take a minimum of five 3-credit courses in chemistry at the 400–500 level (only CHEM 408, 439, 448, and 455 can be used). The candidate's doctoral committee may require additional specific courses.

Qualifying examinations in analytical, biological, inorganic, organic, and physical chemistry will be given to all new students upon entrance in the fall semester. These exams cover subject matter at the level

of the basic courses offered for the B.S. degree in chemistry at Penn State. As a part of the requirements for certification as a Ph.D. candidate, each student will be expected to demonstrate proficiency in three areas of chemistry, including physical chemistry. Such proficiency may be demonstrated either by (a) passing the area examination upon entrance, or (b) obtaining a grade-point equivalent of 3.0 in at least 3 credits of graduate-level course work in the area. The courses to be used to fulfill this latter option will be designated by the graduate counseling committee. This course work must be completed successfully during the student's first two semesters of residence.

In order to qualify for the oral comprehensive examination, a Ph.D. candidate must first obtain a grade of 3.0 or better on 3 credits of CHEM 500 (by writing the requisite number of seminar reports, proposals, and presenting in an area seminar).

A Ph.D. candidate shall take the oral comprehensive examination during his or her first two and one-half years of residency.

Every Ph.D. candidate shall present at least one area or department seminar during the course of residency.

A final oral examination based on a defense of the doctoral thesis is required of all candidates. This exam is given as a formal public seminar with a subsequent closed meeting with the doctoral committee.

Other Relevant Information

All candidates for advanced degrees must schedule CHEM 602, Supervised Experience in College Teaching, for 1 to 2 credits for at least one semester. This requirement may be waived or modified for students who have attained satisfactory competence in teaching as a result of prior experience.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*. It is important to note that department policy limits financial support from *department funds* to the *first two years* of graduate study of an M.S. candidate and to the *first five years* of graduate study of a Ph.D. candidate. Financial support beyond these periods is permitted from other than department funds, e.g., a research assistantship funded from an individual faculty member's research grant(s).

CHEMISTRY (CHEM)

- 400. CHEMICAL LITERATURE (1)
- 402. CHEMISTRY IN THE ENVIRONMENT (3)
- 405. (NUC E) NUCLEAR AND RADIOCHEMISTRY (3)
- 408. (CMPSC) COMPUTER APPLICATIONS IN CHEMISTRY (3)
- 410. INORGANIC CHEMISTRY (3)
- 411. TRANSITION METAL CHEMISTRY (3)
- 425. CHROMATOGRAPHY AND ELECTROCHEMISTRY (3)
- 426. CHEMICAL SPECTROSCOPY (3)
- *431W. ORGANIC AND INORGANIC PREPARATIONS (3)
- 439. STRUCTURAL ANALYSIS OF ORGANIC COMPOUNDS (3)
- 448. SURFACE CHEMISTRY (3)
- *451–452. PHYSICAL CHEMISTRY (3 each)
- 453. THERMODYNAMICS OF CHEMICAL SYSTEMS (3)
- 454. INTRODUCTION TO QUANTUM CHEMISTRY (3)
- 455. PHYSICAL CHEMISTRY OF HIGH POLYMERS (3)
- *457. EXPERIMENTAL PHYSICAL CHEMISTRY (1–2)
- *458. EXPERIMENTAL PHYSICAL CHEMISTRY (1–2)
- 463. CHEMICAL KINETICS (3)
- *489. INTRODUCTION TO CHEMICAL RESEARCH (1–10 per semester, maximum of 20)
- 496. INDEPENDENT STUDIES (1–18)
- 497. SPECIAL TOPICS (1–9)
- 499. FOREIGN STUDIES (1–12)
- 500. SEMINAR IN CHEMISTRY (1 per semester)
- 516. INORGANIC CHEMISTRY (3) Systematic treatment of inorganic chemistry in terms of modern concepts.

*Graduate credit not allowed for students majoring in Biochemistry, Chemistry, or Chemical Engineering.

CIVIL ENGINEERING

517. ORGANOMETALLIC CHEMISTRY (3) Organometallic compounds and their use in catalysis and organic synthesis.
518. PHYSICAL METHODS IN INORGANIC CHEMISTRY (3) Elements of group theory, transition metal electronic spectroscopy, vibrational spectroscopy, magnetic resonance, magnetism, X-ray and photoelectron spectroscopy, X-ray structure determination.
524. ELECTROANALYTICAL CHEMISTRY (3) Modern instrumental methods of analysis; electrochemistry.
525. ANALYTICAL SEPARATIONS (3) Modern instrumental analysis, including chromatography and other separation methods.
526. SPECTROSCOPIC ANALYSIS (3) Modern instrumental analysis, including absorption, emission, electronic, and magnetic spectroscopies.
527. SPECIAL TOPICS IN ANALYTICAL CHEMISTRY (2–12)
531. SPECIAL TOPICS IN ORGANIC CHEMISTRY (3–12) Prerequisite: CHEM 536.
- 535–536. ORGANIC REACTION MECHANISMS I AND II (3 each) Reaction mechanisms and their determination by kinetic and nonkinetic methods. Reactive intermediates. CHEM 439.
537. SYNTHESIS IN ORGANIC CHEMISTRY (3) Theory and methods of directed synthesis, including stereospecific and stereoselective schemes; biologically inspired syntheses. Prerequisite: CHEM 536.
539. MECHANISTIC BIOORGANIC CHEMISTRY (3) Advanced organic reaction mechanisms, particularly those applicable to biological systems. Prerequisites: CHEM 535, BIOCH 401.
540. BIOPHYSICAL CHEMISTRY (3) Structure of biomacromolecules, physical techniques for the study of structure and function, thermodynamic and kinetic studies of biomacromolecules in solution. Prerequisite: CHEM 452.
544. CHEMICAL THERMODYNAMICS (3) Development of thermodynamic theory, with special reference to common physical changes and chemical reactions. Prerequisite: CHEM 452.
545. STATISTICAL THERMODYNAMICS (3) Basic principles of statistical mechanics with application to the calculation of thermodynamic properties of gases and condensed phases. Prerequisite: CHEM 451, 452.
560. TOPICS IN PHYSICAL CHEMISTRY (2–6)
563. CHEMICAL DYNAMICS (3) Molecular dynamics of chemical reaction, energy transfer, and scattering. Reaction rate theory and experiment. Prerequisite: CHEM 565.
565. QUANTUM CHEMISTRY I (3) An introduction to the principles of quantum mechanics and their application to chemistry. Prerequisite: CHEM 452.
566. QUANTUM CHEMISTRY II (3) Modern techniques in quantum mechanics, with applications to problems in molecular structure and interactions. Prerequisites: CHEM 565.
567. MOLECULAR SPECTROSCOPY (3) Principles and methods of molecular spectroscopy and their applications to chemical problems. Prerequisite: CHEM 565.
571. POLYMER CHEMISTRY (3) The synthesis, reactions, and structure determination of high polymers.
589. STUDIES IN CHEMISTRY (1–9) Theoretical research, experimental research, or a critical survey of the literature in an area of chemistry.
597. SPECIAL TOPICS (1–9)

CIVIL ENGINEERING (C E)

PAUL P. JOVANIS, *Head, Department of Civil and Environmental Engineering*
212 Sackett Building
814-863-3084

Degrees Conferred: Ph.D., M.S., M.Eng.

The Graduate Faculty

David A. Anderson, Ph.D. (Purdue) P.E. *Professor of Civil Engineering*
Ana P. Barros, Ph.D. (Washington) *Associate Professor of Civil Engineering*
William D. Burgos, Ph.D. (Virginia Tech) *Assistant Professor of Environmental Engineering*
Eric F. P. Burnett, P.Eng. (U of London) *Professor of Civil Engineering; Bernard and Henrietta Hankin Chair in Residential Building Construction; Director, Pennsylvania Housing Research Center*
Fred S. Cannon, Ph.D. (Illinois, Urbana-Champaign) P.E. *Assistant Professor of Environmental Engineering*
Donald W. Christensen, Jr., Ph.D. (Penn State) *Assistant Professor of Civil Engineering*

Brian A. Dempsey, Ph.D. (North Carolina) *Associate Professor of Environmental Engineering*
 Christopher J. Duffy, Ph.D. (New Mexico Institute of Mining and Technology), P.H. *Associate Professor of Civil Engineering*
 Ageliki Elefteriadou, Ph.D. (Polytechnic University) *Assistant Professor of Civil Engineering*
 William J. Gburek, Ph.D. (Penn State) *Adjunct Associate Professor of Civil Engineering*
 Konstadinos Goulias, Ph.D. (California, Davis) *Associate Professor of Civil Engineering*
 Dennis R. Hiltunen, Ph.D. (Michigan) *Associate Professor of Civil Engineering*
 Peggy A. Johnson, Ph.D. (Maryland) *Associate Professor of Civil Engineering*
 Paul P. Jovanis, Ph.D. (California, Davis) *Professor of Civil Engineering*
 Walter P. Kilareski, Ph.D. (Penn State) P.E., P.L.S. *Professor of Civil Engineering*
 Theodor Krauthammer, Ph.D. (Illinois, Urbana-Champaign) *Professor of Civil Engineering*
 Jeffrey A. Laman, Ph.D. (Michigan) P.E. *Assistant Professor of Civil Engineering*
 Bruce E. Logan, Ph.D. (California, Berkeley) *Kappe Professor of Environmental Engineering*
 John M. Mason, Jr., Ph.D. (Texas A&M) P.E. *Professor of Civil Engineering; Associate Dean for Graduate Studies and Research, College of Engineering*
 Jack V. Matson, Ph.D. (Rice) P.E. *Professor of Environmental Engineering*
 Archibald J. McDonnell, Ph.D. (Penn State) *Professor of Environmental Engineering*
 Arthur C. Miller, Ph.D. (Colorado State) P.E., P.L.S. *Professor of Civil Engineering*
 Martin T. Pietrucha, Ph.D. (Maryland) P.E. *Associate Professor of Civil Engineering*
 Karl Raynar, Ph.D., P.E. (Penn State) *Assistant Professor of Civil Engineering (non-tenure track)*
 Raymond W. Regan, Sr., Ph.D. (Kansas) P.E. *Professor of Environmental Engineering*
 Andrew Scanlon, Ph.D. (Alberta) S.E. *Professor of Civil Engineering*
 Lily Sehayek, Ph.D. (Rutgers) *Assistant Professor of Environmental Engineering (non-tenure track), Penn State Great Valley*
 Shelley M. Stoffels, D.Eng. (Texas A&M) P.E. *Associate Professor of Civil Engineering*
 H. Randolph Thomas, Jr., Ph.D. (Vanderbilt) P.E. *Professor of Civil Engineering*
 Paul J. Tikalsky, Ph.D. (U Texas, Austin) P.E. *Associate Professor of Civil Engineering*
 Richard F. Unz, Ph.D. (Rutgers) *Professor of Environmental Microbiology*
 Mian C. Wang, Ph.D. (California, Berkeley) P.E. *Professor of Civil Engineering*
 Gour-Tsyh Yeh, Ph.D. (Cornell) P.E. *Professor of Civil Engineering*

Students may specialize in construction engineering and management, environmental engineering, hydrosystems engineering, materials, pavement, geotechnical engineering, structural engineering, and transportation engineering.

Admission Requirements

The requirements listed here are in addition to the general requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Candidates should possess a baccalaureate degree from an accredited institution. Students with a 3.00 junior/senior grade-point average (on a 4.00 scale) and appropriate course backgrounds may be considered for admission. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

Applicants must provide the department with official transcripts of all their previous course work (in duplicate), a statement of objectives, and three letters of recommendation AT THE TIME OF APPLICATION. Résumés are encouraged, but not required. In addition, all applicants must submit scores from the General Graduate Record Examination Aptitude Test (verbal, quantitative, and analytical).

The Graduate Record Examination (GRE) program will change significantly in 1999, and this change will affect the graduate admission requirements for the Department of Civil and Environmental Engineering. After the new GRE is introduced, applicants should take the package of the General Test measures containing the Mathematical Reasoning test.

All international applicants whose native language is not English must present an acceptable score (560 minimum on the paper-based test; 220 minimum on the computer-based test) on the Test of English as a Foreign Language (TOEFL).

Applicants for fall admission who wish to be considered for financial aid should COMPLETED applications on file by OCTOBER 31.

Degree Requirements

A thesis is required for the M.S. degree. A writing portfolio is required for the M.Eng. degree. In addition to demonstrating competence in English, each candidate for the Ph.D. degree must satisfy the associated research and communication skills requirements established by the department.

Continuous registration is required for all graduate students until the thesis or writing portfolio is approved.

Other Relevant Information

Students in this program may elect to participate in the dual-title degree program option in Operations Research for the Ph.D. and M.S. degrees.

See also Environmental Engineering.

Student Aid

Graduate assistantships and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*. International applicants who wish to be considered for a teaching assistantship must present an acceptable score (250–300 or 55–60) on the Test of Spoken English (TSE). The TSE can be taken in many countries, or at Penn State after arrival.

CECIL M. PEPPERMAN MEMORIAL GRADUATE FELLOWSHIP—Available to a graduate student in civil or environmental engineering specializing in one of the following fields, listed in order of priority: waste treatment and management, water pollution control, environmental engineering, or related fields.

CIVIL ENGINEERING (C E)

- 400. SEMINAR (1–3)
- 421W. HIGHWAY DESIGN (3)
- 422. TRANSPORTATION PLANNING (3)
- 423. TRAFFIC OPERATIONS (3)
- 431W. CIVIL ENGINEERING CONSTRUCTION (3)
- 432. CONSTRUCTION PROJECT CONTROL (3)
- 433. RESIDENTIAL SUBDIVISION DESIGN AND CONSTRUCTION (3)
- 446. ADVANCED SOIL MECHANICS I (3)
- 447. STRUCTURAL ANALYSIS BY MATRIX METHODS (3)
- 448W. ADVANCED STRUCTURAL DESIGN (3)
- 449W. DESIGN OF PRESTRESSED CONCRETE STRUCTURES (3)
- 451. HYDROLOGIC PROCESS, ANALYSIS, AND DESIGN (3)
- 462. OPEN CHANNEL HYDRAULICS (3)
- 465W. RIVER AND WATERWAYS ENGINEERING (3)
- 471. ENVIRONMENTAL SANITATION (3)
- 472W. WATER POLLUTION CONTROL PROCESSES (3)
- 473. WATER QUALITY MANAGEMENT (3)
- 474. MANAGEMENT OF WATER POLLUTION CONTROL PROCESSES (3)
- 475. (E R M) WATER QUALITY CHEMISTRY (3)
- 476. SOLID WASTE MANAGEMENT (3)
- 477. INDUSTRIAL HAZARDOUS AND RESIDUAL WASTE MANAGEMENT (3)
- 479. ENVIRONMENTAL MICROBIOLOGY LABORATORY (1)
- 481. PAVEMENT MATERIALS AND DESIGN (3)
- 482. PORTLAND CEMENT CONCRETE AND AGGREGATES (3)
- 494. SENIOR THESIS (1–9)
- 496. INDEPENDENT STUDIES (1–18)
- 497. SPECIAL TOPICS (1–9)

- 511. ENGINEERING SOIL CHARACTERISTICS (3) Applications of physicochemical principles in soils engineering; soil composition; factors influencing engineering soil properties. Prerequisite: C E 244.
- 512. SOIL MECHANICS II (2–5) Evaluation of strength parameters and compressibility of soils; elastic analysis of stress and strain; techniques of forecasting foundation settlement; slope stability analysis. Prerequisite: C E 446.
- 513. ADVANCED FOUNDATION ENGINEERING (3) Practical applications of soil mechanics principles to geotechnical engineering problems; dewatering techniques; design of deep foundations and retaining structures. Prerequisite: C E 244.
- 521. TRANSPORTATION NETWORKS AND SYSTEMS ANALYSIS (3) Techniques of transportation network, user, stochastic user, and variable demand equilibrium; transportation activity system; computer simulation techniques and forecasting methods. Prerequisite: 3 credits in computer science.
- 522. TRAFFIC SIMULATION AND CONTROL (3) Simulation theory, traffic modeling using GPSS, traffic signal optimization using TEXAS, EVIPAS, PASSERII, TRANSYT-7F, TRAF-NETSIM, FRESIM, and CORFLO. Prerequisite: C E 423.

523. ANALYSIS OF TRANSPORTATION DEMAND (3) Theories of travel behavior, least squares and maximum likelihood, estimation methods, continuous dependent variable models, utility maximization, discrete econometric techniques. Prerequisite: 3 credits in probability and statistics.
524. ADVANCED PROBLEMS IN CIVIL ENGINEERING MATERIALS (2-6) Study in the literature and by laboratory investigation of selected topics on field-controlled civil engineering materials.
525. TRAFFIC FLOW THEORY (3) Microscopic and macroscopic traffic flow characteristics; traffic stream models, shockwaves and queuing for traffic operations. Prerequisite: C E 423.
526. HIGHWAY AND STREET DESIGN (3) Technical analysis of the design elements of roadways, alignment, cross-section features, and intersection and interchange design considerations. Prerequisite: C E 421W.
527. ROADSIDE DESIGN AND MANAGEMENT (3) Roadside safety and design, safety management, pavement management, lighting, signs, signals, and markings, clear zone, guiderail, impact attenuators. Prerequisite: C E 421W.
531. LEGAL ASPECTS OF ENGINEERING AND CONSTRUCTION (3) Basic legal doctrines, contractual relationships between parties, analysis of construction contract clauses, contract performance, and professional practice problems. Prerequisite: C E 431W.
533. CONSTRUCTION PRODUCTIVITY ANALYSIS AND PERFORMANCE EVALUATION (3) Construction productivity concepts and models; productivity measurement, control, and forecasting; analysis of factors affecting productivity; methods improvement techniques. Prerequisites: STAT 401; C E 431W or A E 474.
539. APPROXIMATE METHODS OF STRUCTURAL ANALYSIS (3) Structural analysis through the application of initial-value methods, Newmark's method, Fourier series, finite difference techniques, and work and energy procedures. Prerequisite: C E 240.
540. STRUCTURAL ANALYSIS BY CLASSICAL METHODS (3) Analysis of continuous trusses and beams, frames, arches, grids, curved beams, suspension systems, and space frames. Prerequisite: C E 240.
541. STRUCTURAL ANALYSIS (3) Theory of various finite elements as applied to civil engineering structures. Term paper required. Prerequisite: C E 447.
544. BEHAVIOR AND DESIGN OF REINFORCED CONCRETE MEMBERS (3) Study of flexure, shear, torsion, compression, combined forces, shrinkage, creep, and deflections applied to beams and frames. Prerequisite: C E 341.
545. DESIGN OF METAL STRUCTURES (3) Steel, aluminum members; flexible connections; composite, hybrid, prestressed beams, tension-field beams; buckling; plastic analysis, design; test data; timber design. Prerequisite: C E 342.
546. REINFORCED CONCRETE SLABS (3) Behavior, analysis, and design of floor systems; elastic, ACI Code method, yield line theory; two-way, flat slab, flat plate. Prerequisite: C E 341.
548. STRUCTURAL DESIGN FOR DYNAMIC LOADS (3) Dynamic behavior of structural systems of one or more degrees of freedom; earthquake, blast-resistant analysis, and design of structures. Prerequisites: E MCH 012, C E 240.
550. ENGINEERING CONSTRUCTION MANAGEMENT (3) Management fundamentals for construction contracting; organization, project planning, scheduling and control, bonding and insurance, labor legislation and regulation, cost and control. Prerequisite: C E 431W.
551. RANDOM PROCESSES IN HYDROLOGIC SYSTEMS (3) Hydrologic systems analysis, simulation; design using probability, time series and dynamical systems; formulating models, parameter estimation, environmental impact, resource assessment. Prerequisites: C E 351; introductory probability and statistics.
553. PLANNING MULTIPURPOSE HYDROLOGIC SYSTEMS (3) Study of multipurpose hydrologic schemes within a social, economic, and political framework. Prerequisites: C E 451, ECON 014.
554. URBAN HYDROLOGY (3) Several hydrograph methods. Design storm and IUH application; airport drainage; flood plains; impact of urbanization upon groundwater and sediment. Prerequisite: C E 451.
555. GROUNDWATER HYDROLOGY: ANALYSIS AND MODELING (3) Introduction to groundwater resource analysis, model formulation, simulation, and design of water resource systems using symbolic and numerical methods. Prerequisites: C E 451, MATH 251.
556. TRACER AND CONTAMINANT TRANSPORT IN GROUNDWATER SYSTEMS (3) Introduction to mathematical models for tracer and contaminant transport in groundwater. Topics include formulation, visualization, environmental tracers, and remediation. Prerequisites: C E 451, MATH 251.
557. COMPUTATIONAL SUBSURFACE HYDROLOGY I: FLOW (3) Subsurface flow processes, numerical methods, practical matrix solvers, flow equations, algorithm development, coding consideration, subsurface flow codes, field problem application. Prerequisites: C E 351 or 451; E MCH 407.

558. COMPUTATIONAL SUBSURFACE HYDROLOGY II: FATE AND TRANSPORT (3) Transport processes, numerical methods for advection-dominant transport, fate and transport codes, geochemical equilibrium, geochemical kinetics, microbes dynamics, biodegradation, heat transport. Prerequisites: C E 351 or 451; C E 557, E MCH 407.
560. DIMENSIONAL ANALYSIS AND THEORY OF MODELS (3) Principles of dimensional analysis and similitude, with engineering applications primarily to problems in hydromechanics. Prerequisite: C E 261.
561. FUNDAMENTALS OF SURFACE HYDROLOGY (3) Integrated analysis of surface energy/water balances at the land surface. Emphasis on physical processes and quantification of water pathways. Prerequisite: A B E 467 or C E 451.
562. SCALING ISSUES IN SURFACE HYDROLOGY (3) Emphasis on acquisition of quantitative skills to analyze and interpret multiscale data, development of physically based models of complex hydrologic processes. Prerequisite: C E 561.
564. HYDRAULIC ENGINEERING DESIGN (3) Design and analysis of selected units of a typical hydraulic engineering project. Prerequisite: C E 362.
570. ENVIRONMENTAL AQUATIC CHEMISTRY (3) Speciation, reactivity, and distribution of contaminants in water, with emphasis in inorganic chemicals. Prerequisite: C E 475.
571. PHYSICAL-CHEMICAL TREATMENT PROCESSES (3) The theory of physical-chemical processes used in the treatment of potable water and municipal and industrial wastewaters. Prerequisite: C E 472W and 475.
572. BIOLOGICAL TREATMENT PROCESSES (3) The theory of biological processes used in the treatment of municipal and industrial wastewaters. Prerequisite or concurrent: C E 475, MICRB 400.
573. FATE AND TRANSPORT OF HAZARDOUS CHEMICALS (3) Theory, measurement, and estimation of the transformations of hazardous materials in ambient environments. Prerequisite: C E 475.
574. LABORATORY ANALYSES IN WATER QUALITY CONTROL (3) Experiments illustrating current chemical and biochemical methods of water and waste treatment and analytical methods used in research and control. Prerequisite: C E 475.
575. INDUSTRIAL WASTE MANAGEMENT (2) Surveys and analysis, pollution prevention, regulatory requirements, treatment and disposal of liquid, gaseous, and solid residues. Prerequisite: C E 472W.
577. TREATMENT PLANT DESIGN (1–6) Design of works for the treatment of water and wastewater for municipalities and industries. Prerequisites: C E 472W; 3 credits in hydraulics.
579. ENVIRONMENTAL POLLUTION MICROBIOLOGY (3) Fundamentals of microorganisms in water and wastewater treatment; indicators of pollution; activities of microorganisms in polluted waters, including biogeochemical cycles. Prerequisite: MICRB 400.
580. SURFACE WATER QUALITY MODELS (3) Development and application of water quality models for rivers, lakes, and estuaries; biological and chemical reactions in natural systems. Prerequisite: C E 270.
581. PAVEMENT MANAGEMENT AND REHABILITATION (3) Techniques of network and project level pavement management, field evaluation methods and equipment, maintenance and rehabilitation strategies, overlay design procedures. Prerequisite: C E 421W.
582. PAVEMENT DESIGN AND ANALYSIS (3) Viscoelastic analysis; nonlinear analysis; fatigue and permanent deformation; back-calculation of layer moduli; mechanistic-empirical design methods. Prerequisite: C E 481.
583. BITUMINOUS MATERIALS AND MIXTURES (3) Composition, physical behavior, production, and performance of bituminous materials and mixtures. Prerequisite: C E 481.
584. CONCRETE MATERIALS AND PROPERTIES (3) Study of concrete properties and associated variables, prediction models, testing, preventive measures, pozzolans, admixtures. Prerequisite: A E 221 or C E 280.
590. COLLOQUIUM (1–3)
596. INDIVIDUAL STUDIES (1–9)
597. SPECIAL TOPICS (1–9)
598. SPECIAL TOPICS (1–9)

COMMUNICATION DISORDERS (CMDIS)

GORDON W. BLOOD, *Head of the Department*
 Department of Communication Disorders
 110 Moore Building
 814-865-3177

Degrees Conferred: Ph.D., M.S.

The Graduate Faculty

Gordon W. Blood, Ph.D. (Bowling Green) *Professor of Communication Disorders*
 Ingrid M. Blood, Ph.D. (Bowling Green) *Professor of Communication Disorders*
 Thomas A. Frank, Ph.D. (Wisconsin) *Professor of Communication Disorders*
 Carol Hammer, Ph.D. (Iowa) *Assistant Professor of Communication Disorders*
 Lynne E. Hewitt, Ph.D. (SUNY, Buffalo) *Assistant Professor of Communication Disorders*
 Janice C. Light, Ph.D. (Toronto) *Associate Professor of Communication Disorders*
 Adele W. Miccio, Ph.D. (Indiana, Bloomington) *Assistant Professor of Communication Disorders*
 Robert A. Prosek, Ph.D. (Purdue) *Professor of Communication Disorders*
 Constance Qualls, Ph.D. (Memphis) *Assistant Professor of Communication Disorders*
 Nancy L. Records, Ph.D. (Iowa) *Assistant Professor of Communication Disorders*

The goals of the program in Communication Disorders are to train professionals to conduct research and be consumers of research in communication disorders and to prepare competent professionals to habilitate and rehabilitate individuals who have speech, language, and/or hearing problems. The program also serves to provide students in other curricula at Penn State with orientation toward and information about communication disorders.

Facilities for student training and research include in-house clinical therapy and diagnostic services, laboratories in speech science and audiology, and affiliated schools and clinics. The program enjoys academic, research, and clinical relationships with a number of related programs at Penn State and draws upon academic work from related areas as part of the graduate training in communication disorders. Preparation is given for school and professional certifications and licensure. The CMDIS academic program is accredited by the Council of Academic Affairs of the American Speech-Language-Hearing Association. The program is also accredited by the Professional Services Board of the American Board of Examiners in Speech Pathology and Audiology (ABESPA) for speech pathology and audiology for both academic training and clinical services. Graduate study requires a full-time externship experience, ordinarily occurring during the final semester of study.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are required for admission. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Approximately 35 credits are required for admission, distributed among speech pathology, audiology, speech science, education, and psychology, and including a course in statistics. Students entering without an undergraduate degree in CMDIS may be required to take additional make-up work.

Students with a 3.00 junior/senior average (on a 4.00 scale) and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Usually students earn a master's degree in communication disorders prior to being considered for doctoral study, although persons with master's degrees in other fields will be considered for a doctoral program.

Master's Degree Requirements

The master's degrees require a minimum of 50 graduate credits beyond admission standards. Students usually earn 55 to 65 credits to complete a degree, over four semesters and a summer of study.

There is a nonthesis option for the Master of Science degree, requiring a paper and additional course credits in lieu of a thesis. The master's program of study provides course work and practicum for advanced and/or professional-level licensure.

Doctoral Degree Requirements

The Doctor of Philosophy degree normally requires a master's degree in communication disorders or a related field, plus a minimum of two years of advanced study, and presentation and oral defense of a research-based dissertation.

COMMUNICATION DISORDERS

The communication and foreign language requirement is a minimum of 6 credits of statistics beyond the first course, plus 9 credits selected from among statistics, technical writing, computer science, research design, or a foreign language.

Two research exercises, one of which is used for doctoral candidacy evaluation early in the doctoral program, are required prior to the dissertation. Comprehensive written examinations in the areas of a student's interest and an optional minor field examination, plus an oral examination prior to dissertation, are required.

Details of a student's doctoral program are determined by the doctoral committee.

Student Aid

Fellowships, traineeships, graduate assistantships, and other forms of financial aid are described in the STUDENT AID section of the *Graduate Bulletin*.

COMMUNICATION DISORDERS (CMDIS)

- 430. INTRODUCTION TO AUDIOLOGY (3)
- 433. AURAL REHABILITATION (3)
- 442. INTRODUCTION TO DISORDERS OF ARTICULATION AND PHONOLOGY (3)
- 444. INTRODUCTION TO ORGANIC DISORDERS OF SPEECH AND LANGUAGE (3)
- 445. PROFESSIONAL PROGRAMS AND RELATIONSHIPS (2)
- 450. USE OF TECHNOLOGY IN COMMUNICATION DISORDERS (3)
- 451. AN INTRODUCTION TO AUGMENTATIVE AND ALTERNATIVE COMMUNICATION (3)
- 459W. PRINCIPLES OF CLINICAL MANAGEMENT IN COMMUNICATION DISORDERS (3)
- 462. CLINICAL BASES OF LANGUAGE DISORDERS (3)
- 463. TEACHING LANGUAGE TO THE HEARING IMPAIRED (3)
- 464. TEACHING SCHOOL SUBJECTS TO THE DEAF (2)
- 468. SIGN LANGUAGE II (2)
- 469. SIGN LANGUAGE III (2)
- 495A. SPEECH THERAPY PRACTICUM (1-6)
- 495B. HEARING IMPAIRMENT PRACTICUM (1-6)
- 495C. HEARING IMPAIRMENT INTERNSHIP (6-15)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

- 500. RESEARCH METHODS IN COMMUNICATION DISORDERS (1) Methodology necessary for understanding and conducting research in communication disorders. Prerequisites: 15 credits in communication disorders.
- 515. APPLICATION OF PHYSIOLOGICAL AND ACOUSTICAL CONCEPTS OF SPEECH PATHOLOGY AND AUDIOLOGY (3) Application of practical and theoretical concepts in neurology, physiology, and acoustics to communication disorders, with implications for clinical therapy. Prerequisites: 6 credits in speech science; 6 credits in communication disorders.
- 516. NEUROLOGICAL FOUNDATIONS OF COMMUNICATION DISORDERS (2) Clinical correlates of neuroanatomy and physiology to communication disorders; application of concepts to clinical practice. Prerequisites: 12 credits in communication disorders, to include CMDIS 431.
- 520. PHYSIOLOGIC AND ACOUSTIC ISSUES IN SPEECH SCIENCE (3) Seminar in the physiologic and acoustic aspect of normal and disordered speech production. Prerequisites: 12 credits in communication disorders.
- 522. (SPCOM) SPEECH PERCEPTION (3) Transformation of linguistic units into acoustic speech signals, theories of speech perception, and auditory processing of the speech signals. Prerequisites: SPCOM 410, 431, and 520.
- 531. HEARING AIDS (4) Hearing aid circuitry, electroacoustic and real ear measurement, hearing aid evaluation, follow-up procedures, and new advances for infants, children, and adults. Prerequisite: CMDIS 535.
- 532. INSTRUMENTATION I (3) Acoustical instrumentation used for research in hearing, programs of hearing conservation and noise control, including clinical and industrial applications. Prerequisites: 6 credits in acoustics, audiology, experimental psychology, or speech science at the 400 level.
- 534. NOISE AND HEARING (2) Noise-induced hearing problems; interference with communication; annoyance and community problems caused by acoustic energy; regulations and standards. Prerequisites: CMDIS 430, 433, 6 credits in speech pathology and audiology.

535. **PURE TONE AUDIOMETRY AND IMMITANCE MEASURES** (4) Techniques, interpretation, and differential diagnosis of hearing by pure tone audiometry, immitance measures, and related techniques. Prerequisite: CMDIS 430.
540. **PHONOLOGICAL DISABILITIES** (3) Speech-sound production disorders in children and adults; methods of examination, diagnosis, and treatment. Prerequisite: CMDIS 442, 495A.
541. **THE VOICE AND ITS DISORDERS** (3) Physical, physiological, and psychological bases of voice production; causes, nature, and symptoms of its disorders; current clinical methods in voice improvement. Prerequisite: CMDIS 444, 495A.
542. **STUTTERING** (3) Modern theories of causes of disorders of rhythm, methods of examination, diagnosis, and treatment. Prerequisite: CMDIS 442, 495A.
543. **DIAGNOSTIC PROCEDURES IN SPEECH PATHOLOGY** (3) Clinical instrumentation; case history taking, examination procedures and materials used in diagnosing speech disabilities; interpretation of findings; report preparation. Prerequisites: 15 credits in communication disorders.
544. **CLEFT PALATE** (3) Anatomy, physiology, embryology, and growth of the palate and contiguous structures; etiology, diagnosis, habilitation of cleft palate problems. Prerequisite: CMDIS 444.
545. **NEUROMOTOR DISORDERS OF SPEECH** (3) Etiology and symptomatology of dysarthric and apraxic speech; diagnosis, treatment, and the team rehabilitative program approach to these disorders. Prerequisite: CMDIS 444, 515, or SPCOM 431.
546. **LANGUAGE DISORDERS IN ADULTS** (3) Nature, etiology, diagnosis, and management of language disorders in adults. Prerequisites: 9 credits in communication disorders or related fields such as psychology, linguistics, or human development.
547. **LANGUAGE DISORDERS IN CHILDREN** (3) Nature, etiologies, diagnosis, and management of language disorders in children. Prerequisites: CMDIS 300; 6 credits in related fields.
550. **SEMINAR IN COMMUNICATION DISORDERS** (1–6) Advanced study of special problems and new developments in communication disorders. Prerequisites: 10 credits in communication disorders.
551. **ASSESSMENT AND INTERVENTION IN AUGMENTATIVE AND ALTERNATIVE COMMUNICATION** (3) Research results in augmentative and alternative communication (AAC); implications for assessment, prescription of AAC systems, and intervention planning in AAC. Prerequisite: CMDIS 451.
567. **AUDIOLOGY FOR HEARING AND SPEECH CLINICIANS** (3) Etiology, measurement, and differential diagnosis of hearing loss; overview of aural rehabilitation, including hearing aids and auditory training systems. Prerequisites: CMDIS 430, 433; 6 credits in communication disorders.
572. **PSYCHOACOUSTICS IN COMMUNICATION DISORDERS** (4) Perceptual phenomena of normal audition supported by reviews of methods and principles of psychophysical measurement and of hearing theory. Prerequisites: 6 credits of acoustics or communication disorders.
574. **PEDIATRIC AUDIOLOGY** (3) Etiology, differential diagnosis, habilitation, and rehabilitation of hearing loss associated with infants, preschool, and school-age children. Prerequisite: CMDIS 535 or 567.
575. **SPEECH AND SPECIAL AUDIOLOGICAL TESTS** (4) Theory, administration, and interpretation of special audiological tests to determine the site of lesion of a hearing loss. Prerequisites: CMDIS 430.
576. **AURAL REHABILITATION II** (3) Practical and theoretical methods for improving communication skills of hearing impaired and deaf infants, children, and adults. Prerequisite: CMDIS 433.
577. **ELECTROPHYSIOLOGICAL MEASUREMENTS OF HEARING** (3) Application of auditory evoked potential measurements to the clinical assessment of auditory sensitivity. Prerequisite: CMDIS 535.
578. **INSTRUMENTATION II** (1) Experience in operating modern, computer-based equipment used in hearing science and speech science research. Prerequisite: CMDIS 532.
579. **ELECTRONYSTAGMOGRAPHY** (2) Anatomy, physiology, and measurement of the human vestibular system, and differential diagnosis of vestibular system function. Prerequisite: CMDIS 430.
- 595A. **SPEECH THERAPY PRACTICUM** (1–6) Theoretical and clinical rationale of therapy; professional role and relationships; therapy procedures, individual and group; evaluation of process and outcomes. Prerequisites: CMDIS 442 and 495A.
- 595C. **SPEECH THERAPY EXTERNSHIP** (7–15) Full-time externship experience in speech therapy and diagnostic procedures at an off-campus site. Prerequisites: 30 credits in communication disorders.
- 595E. **AUDIOLOGY PRACTICUM** (1–5) Prerequisite: CMDIS 531.
- 595F. **AUDIOLOGY EXTERNSHIP** (7–15) Full-time externship experience in audiologic procedures at an off-campus site selected by the Communication Disorders department staff. Prerequisites: 30 graduate credits in communication disorders.
- 595G. **SPEECH DIAGNOSTICS PRACTICUM** (1–3) Supervised practice in interviewing, counseling, speech evaluation, and synthesis of psychological, medical, and audiological data in speech diagnosis; report writing. Prerequisite: CMDIS 444 and 495A.

595I. SPEECH PATHOLOGY III (1–2) Internship.

595J. AUDIOLOGY III (1–2) Internship.

596. INDIVIDUAL STUDIES (1–9)

597. SPECIAL TOPICS (1–9)

COMMUNITY PSYCHOLOGY (CMPSY)

ROBERT W. COLMAN, *Coordinator*

W-157 Olmsted Building

Penn State Harrisburg

Middletown, PA 17057

717-948-6036

Degree Conferred: M.C.P. (Master of Community Psychology)

The Graduate Faculty

Holly Angelique, Ph.D. (Michigan State) *Assistant Professor of Community Psychology*

John G. Bruhn, Ph.D. (Yale) *Professor of Sociology*

Robert W. Colman, Ph.D. (North Carolina) *Assistant Professor of Social Science and Psychology*

Stephen R. Couch, Ph.D. (SUNY) *Professor of Sociology*

Stephanie Field, Ph.D. (Delaware) *Assistant Professor of Sociology*

Daniele Flannery, Ph.D. (Wisconsin, Madison) *Assistant Professor of Education*

Ida Marie Gentzler, Ph.D. (Temple) *Assistant Professor of Social Science*

Clemmie E. Gilpin, Ph.D. (Penn State) *Assistant Professor of Community Systems and Afro-American Studies*

James F. Rooney, Ph.D. (Pennsylvania) *Professor of Sociology*

Robert A. Scott, Ph.D. (Penn State) *Assistant Professor of Behavioral Science and Education*

Katherine L. Towns, Ph.D. (Penn State) *Professor Emerita of Educational Psychology and Women's Studies*

The graduate program in Community Psychology leads to a Master of Community Psychology degree with concentrations in Human Services Management and in Individual Studies. The nontraditional program emphasizes planned social change, and is based on both sociology and psychology. The program equips students with skills useful in coping with the multifaceted problems facing communities. Students learn (a) to assess problems at the level of communities or organizations, (b) to plan and implement possible solutions to these problems, and (c) to evaluate the effectiveness of the solutions. Learning takes place both in courses and in a master's project that entails fieldwork and the writing of a master's paper.

To act as a change agent, the student must be aware of contemporary community needs, along with the impact of the community structure upon its individual members, and the techniques best suited to initiate productive changes. After completing this interdisciplinary program, the graduate should be able to approach problems with a more integrated point of view and work cooperatively with community individuals and agencies toward practical solutions. Problems relating to crime, education, employment, housing, the lack of effective social power, and other factors affecting psychological well-being are approached from bases in community service agencies or informal community groups. The majority of students work full time in agencies or governmental units. To accommodate these working students, most 500-level graduate courses are scheduled in the evening.

The curriculum for this program, as well as the title of the degree conferred, are under review. Current information is available from the program coordinator.

Admission Requirements

Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

For admission to the program, a student must have a baccalaureate degree from an accredited academic institution, earned under residence and credit conditions substantially equivalent to those required by Penn State. The minimum grade-point average (GPA) in the junior and senior years must be 3.00 or higher (on a 4.00 scale). Students with experience in carrying out planned social change are particularly encouraged to apply. Most applicants hold degrees in psychology, sociology, or related disciplines. Ideally, applicants will have taken courses in developmental, personality, and social psychology, along with work in social change, social problems, and social conflict. Students from diverse backgrounds are welcome to apply,

particularly if they have had work or other experience effecting change in community settings. Applicants may be asked to take additional course work without graduate credit, chosen after consultation with an adviser, if they have had no psychology or sociology courses beyond the introductory level. Applicants must have received a C or better in an introductory statistics course covering parametric and nonparametric inferential statistics; they will be requested to make up any deficiency without graduate credit.

Transfer credits from accredited institutions will be evaluated by the program coordinator for recency and appropriateness to the students' course of study. Approval for up to 10 transfer credits may be given.

The program entails a master's project, including both a practicum (CMPSY 522) and a master's paper (CMPSY 530). Documented applications for credit for work experience will be evaluated by the student's master's committee, made up of members of the graduate faculty. Approval for up to 6 credits may be given. If approval is granted, the student has the option of either registering for the number of CMPSY 522 credits approved or asking for a waiver of the CMPSY 522 requirement and taking additional course work in its place.

Courses in the program are sequenced on the assumption that students will be entering in the fall semester. Students may apply for admission for the spring (but not the summer) semester, but they may not start taking 500-level required courses until the following fall.

Admission to the Community Psychology program is based on clear suitability for the program as evidenced by the application as a whole; it is limited to the number of spaces available for master's project supervision.

Applicants must submit the following: a completed application form; two copies of official transcripts from colleges or universities previously attended (including The Pennsylvania State University); scores from the Graduate Record Examination (GRE) General Test, including verbal, analytical, and quantitative reasoning sections; a letter of about 500 words outlining significant community or work experience, along with career and academic objectives; three letters of recommendation; and the application fee.

The application, fee, and associated materials should be sent to Penn State Harrisburg, Enrollment Services, 777 W. Harrisburg Pike, Middletown, PA 17057-4898. In addition, applicants with strong records but whose suitability to the program may be unclear may be asked to visit the campus for an interview.

Program Requirements

To qualify for the degree, students are required to complete 36 credits, 24 of which must be at the 500 level. There is a sequence of substantive courses, starting with Theories and Issues in Community Psychology (CMPSY 500).

An important part of this degree is a master's project, made up of a total of 9 credits, comprising from 3 to 6 credits of practicum (CMPSY 522), and from 3 to 6 credits of research (CMPSY 594). This project is planned in the context of the course Roles and Methods in Community Psychology (CMPSY 521); it is supervised by a master's committee of graduate faculty. The particular mix of practicum and research is worked out by the student in consultation with the faculty. The variable mix of practicum and research credits results in the student's being able to choose course work that emphasizes study in the area in which she or he needs most skill development. In the usual case, a student with a strong background in fieldwork would be asked to emphasize research in her or his master's project, and a student with a strong research background, but with limited fieldwork, would be asked to emphasize the practicum. The output of CMPSY 522 is a practicum; the output of the research course CMPSY 594 is a required master's paper of at least 3 credits. The master's paper may be based on the field experience. Students often choose to structure their master's paper around a specific community research problem. Again, students can apply for practicum (CMPSY 522) credit, or at their choice, for a waiver of the requirement, on the basis of documented prior experience. Decisions about such applications are made by the student's master's committee.

Most part-time students are able to complete the degree in six to seven semesters. Since the processes of designing a master's project and of writing a master's paper are labor-intensive and frequently take more time than the student expects, even full-time students often need five or more semesters to complete the degree.

The program offers two concentrations, each including all the required Community Psychology courses. The Human Services Management concentration uses as its electives 9 approved credits from the Master of Public Administration program. The Individualized concentration uses as its electives courses chosen to meet individual needs, with the approval of an adviser.

REQUIRED COURSES: 27 credits

CMPSY 500, 510, 511, 520, 521, 522, 594, SCLSC 470

COMMUNITY PSYCHOLOGY

ELECTIVE COURSES: 9 credits

Individualized concentration—Students select electives from a wide variety of courses offered by the Behavioral Science and other faculties. The object is to support a special area of interest in, for instance, adult education, criminal justice, urban sociology, women's studies, or issues of classism, racism, or sexism. Students work with faculty advisers in gaining approval of electives and in choosing topics for the master's project.

Human Services Management concentration—Students must complete three of the following: P ADM 500, 502, 505, 510, 511, 522.

Student Aid

A number of scholarships, fellowships, and graduate assistantships are available. Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

COMMUNITY PSYCHOLOGY (CMPSY)

500. THEORIES AND ISSUES IN COMMUNITY PSYCHOLOGY (3) Contemporary issues in community psychology will be discussed within the framework of its development from clinical and social psychology.

510. CHANGE PROCESSES (3) Social change as it takes place within institutions and communities.

511. SOCIAL IMPACTS ON PSYCHOLOGICAL FUNCTIONING (3) Psychological functioning, as it is affected by social contexts. Prerequisite: CMPSY 500, permission of program.

520. TECHNIQUES IN ACTION RESEARCH (3) Methods for evaluating programmatic social change. Prerequisite: SCLSC 320.

521. ROLES AND METHODS IN COMMUNITY PSYCHOLOGY (3) Advanced course entailing the development of master's projects with both fieldwork and research; each student writes a formal proposal. Prerequisite: permission of program, for degree candidates only.

522. PRACTICUM (3–6) Fieldwork implementing planned changes. Prerequisites: CMPSY 500, 510, 511, 520, 521, for degree candidates only.

590. COLLOQUIUM (1–3)

594. RESEARCH (3–6) Supervised research on a master's paper. Prerequisite: for degree candidates only.

596. INDIVIDUAL STUDIES (1–9)

597. SPECIAL TOPICS (1–9)

SOCIAL SCIENCE (SCLSC)

470. ADVANCED STATISTICAL AND DESIGN METHODS (3)

COMPARATIVE AND INTERNATIONAL EDUCATION (CI ED)

DAVID POST, *Chair of the Committee on Comparative and International Education*
306 Rackley Building
814-865-1488

Degrees Conferred: Students electing this option through participating programs earn a degree with a dual title in both the Ph.D. (or D.Ed.) and the M.A., M.S., or M.Ed. levels, e.g., Ph.D. in (graduate program name) and Comparative and International Education or M.A. in (graduate program name) and Comparative and International Education.

The Graduate Faculty

David P. Baker, Ph.D. (Johns Hopkins) *Professor of Education and Sociology*

William L. Boyd, Ph.D. (Chicago) *Distinguished Professor of Education*

Constance Flanagan, Ph.D. (Univ. of Michigan) *Associate Professor of Comparative/International Education and Extension Education*

Roger L. Geiger, Ph.D. (Michigan) *Professor of Education*

Gerald LeTendre, Ph.D. (Stanford) *Assistant Professor of Education*

Suet-ling Pong, Ph.D. (Chicago) *Associate Professor of Education and Demography*

David Post, Ph.D. (Chicago) *Associate Professor of Education*

Ladislav Semali, Ph.D. (California, Los Angeles) *Assistant Professor of Education*

Frank C. Worrell, Ph.D. (California, Berkeley) *Assistant Professor of Education*

The Comparative and International Education dual-title degree program option is administered by the Committee on Comparative and International Education. The committee maintains program definition, identifies courses appropriate to the option, develops and administers the program's comprehensive examination, and recommends policy and procedures for the program's operation to the dean of the College of Education and to the dean of the Graduate School. Members of the committee also chair or co-chair the dissertation committees for students electing the dual-title doctoral degree.

The dual-title degree program is offered through participating programs in the College of Education and, where appropriate, other graduate programs in the University. The option enables students from several graduate programs to gain the perspectives, techniques, and methodologies of comparative and international education, while maintaining a close association with program areas of application. Comparative and international education is a field devoted to the systematic analysis of the operation and effects of the world's education systems. For admission to pursue a dual-title degree under this program, a student must apply to (1) the Graduate School; (2) one of the participating graduate major programs; and (3) the committee on Comparative and International Education.

Admission Requirements

Program candidates will be required to take the Graduate Record Examination, to provide a writing sample, and, where appropriate, a satisfactory TOEFL score, and to submit a written personal statement indicating the career goals they hope to serve by attaining a Comparative and International Education degree.

Degree Requirements

To qualify for a dual-title degree, students must satisfy the requirements of the graduate major programs in which they are enrolled, in addition to the minimum requirements of the Comparative and International Education program.

For the M.A., M.S., or M.Ed. dual-title degree in Comparative and International Education, the minimum course requirements are: 6 credits in the required Proseminars in Comparative and International Education; 6 credits in advanced Comparative and International Education courses; and 3 credits in Comparative and International Education content courses (or additional advanced graduate major program requirements and those in the Comparative and International Education program. Candidates for the dual-title master's degree in Comparative and International Education will also be required to pass a written comprehensive examination based on a set of core readings established by the committee.

A master's thesis or master's paper is required, depending upon the student's graduate major program, the supervisor of which must be a member of the graduate faculty recommended by the chair of the program granting the degree and approved by the Committee on Comparative and International Education as qualified to supervise work in Comparative and International Education.

The minimum course requirements for the Ph.D. (or D.Ed.) dual-title degree in Comparative and International Education are: 6 credits in the Proseminars in Comparative and International Education; 6 credits in advanced Comparative and International Education courses; 6 credits in Comparative and International Education content courses (or additional advanced Comparative and International Education courses); 6 credits in courses with comparative or international content offered outside the College of Education; and 6 credits in research methods. Students are expected to be fluent in reading, writing, and speaking English, and must demonstrate competency in reading a language other than English, preferably a language relevant to a country or geographic area they propose to study. (This foreign language requirement can be satisfied by passing the appropriate ETS Language Achievement Test, or by passing the appropriate Penn State foreign language course.) A minimum of 18 credits must be 500-level course, and particular courses may satisfy both the graduate major program requirements and those in the Comparative and International Education program. Candidates for the dual-title doctoral degree in Comparative and International Education will also be required to pass a written comprehensive examination based on a set of core readings established by the committee.

A Ph.D. (or D.Ed.) minor program in Comparative and International Education is available to doctoral students who find it desirable to include the perspectives and methodologies of Comparative and International Education in their programs and have been approved to do so by their doctoral committees. To qualify for a minor in Comparative and International Education, students must satisfy the requirements of their graduate major programs, and meet the following minimum requirements: 6 credits in the Proseminars in Comparative and International Education; 3 credits in an advanced Comparative and International Education course; and 6 credits in Comparative and International Education content courses (or advanced courses) or in courses with comparative or international content offered outside the College of Education.

COMPARATIVE LITERATURE

The doctoral dissertation committee of a Ph.D. (or Ed.D.) dual-title degree student is recommended, in conjunction with the Comparative and International Education committee, by the graduate major program granting the degree. The chair and at least two members of a doctoral committee must be members of the graduate faculty. The chair or co-chair of the dissertation committee must be a member of the Comparative and International Education committee.

COMPARATIVE AND INTERNATIONAL EDUCATION (CI ED)

470. (ADTED) INTRODUCTION TO DISTANCE EDUCATION (3)

500. COMPARATIVE EDUCATION PROSEMINAR I (3) Methods of comparative education and case studies of governance and administration; first of two-part sequence.

501. COMPARATIVE EDUCATION PROSEMINAR II (3) Second course of two-part sequence; causes and consequences of increased school worldwide.

502. (EDTHP 506, HI ED) EDUCATIONAL MOBILITY IN COMPARATIVE PERSPECTIVE (3) Role of education in social mobility, using quantitative, qualitative, and historical methods; focuses comparatively on Britain, East Asia, and South America.

503. (EDTHP 507, HI ED) ETHNICITY, NATIONAL IDENTITY, AND EDUCATION (3) Surveys group-oriented education policies internationally, especially comparing those of Britain, Taiwan, India.

504. (C I) PERSPECTIVES IN AFRICAN EDUCATION (3) Educational systems in selected African countries are examined with respect to colonial history, and social, political, and cultural factors.

516. (EDTHP) EDUCATION AND DEMOGRAPHIC CHANGE IN THE UNITED STATES AND ABROAD (3) Interrelationship between schooling and employment, marriage, fertility, and migration. Focus comparatively on the United States and developing countries.

570. (ADTED) COMPARATIVE AND INTERNATIONAL ADULT EDUCATION (3) Critical and comparative analysis of adult education theory and practice outside North America, including international agency involvement. Prerequisite: ADTED 460.

571. (HI ED) COMPARATIVE HIGHER EDUCATION (3) Comparative methods of studying structural variations in systems of higher education in principal industrialized nations and other selected countries.

590. COLLOQUIUM (1-3)

594. RESEARCH TOPICS (1-18)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

COMPARATIVE LITERATURE (CMLIT)

CAROLINE D. ECKHARDT, *Head, In Charge of Graduate Programs in Comparative Literature*
311 Burrowes Building
814-863-0589

Degrees Conferred: Ph.D., M.A.

The Graduate Faculty

Mary Barnard, Ph.D. (Michigan) *Associate Professor of Spanish and Comparative Literature*

Thomas O. Beebee, Ph.D. (Michigan) *Associate Professor Comparative Literature and German*

Stacy N. Beckwith, Ph.D. (Minnesota) *Assistant Professor of Comparative Literature and Jewish Studies*

Michael H. Begnal, Ph.D. (Washington) *Professor of English and Comparative Literature*

Alegria Bendelac, Ph.D. (Columbia) *Professor Emerita of French*

Kevin J. H. Berland, Ph.D. (McMaster) *Assistant Professor of English*

Patrick G. Cheney, Ph.D. (Toronto) *Associate Professor of English and Comparative Literature*

William G. Crisman, Ph.D. (California, Berkeley) *Associate Professor of English, German, and Comparative Literature*

Frederick A. deArmas, Ph.D. (North Carolina, Chapel Hill) *Professor of Spanish and Comparative Literature*

Ellen H. Douglass, Ph.D. (Brown) *Assistant Professor of Comparative Literature and Women's Studies*

Aminadav A. Dykman, Ph.D. (Geneva) *Assistant Professor of Comparative Literature and Hebrew*

Caroline D. Eckhardt, Ph.D. (Michigan) *Professor of English and Comparative Literature*

Robert Edwards, Ph.D. (California, Riverside) *Professor of English and Comparative Literature*

Richard Frushell, Ph.D. (Duquesne) *Associate Professor of English and Comparative Literature*

- Robert Ginsberg, Ph.D. (Pennsylvania) *Professor of Philosophy*
 Kathryn M. Grossman, Ph.D. (Yale) *Associate Professor of French*
 Thomas A. Hale, Ph.D. (Rochester) *Professor of African, French, and Comparative Literature*
 Evelyn Hovanec, Ph.D. (Pittsburgh) *Associate Professor of English*
 Linda J. Ivanits, Ph.D. (Wisconsin) *Associate Professor of Russian and Comparative Literature*
 Djelal Kadir, Ph.D. (New Mexico) *Edwin Erle Sparks Professor of Comparative Literature*
 Chiyoko Kawakami, Ph.D. (Washington) *Assistant Professor of Comparative Literature and Japanese*
 Alan E. Knight, Ph.D. (Yale) *Professor Emeritus of French*
 W. LaMarr Kopp, Ph.D. (Penn State) *Professor Emeritus of German*
 Jeanne Krochalis, Ph.D. (Harvard) *Associate Professor of English*
 Arthur O. Lewis, Ph.D. (Penn State) *Professor Emeritus of English*
 Robert F. Lima, Jr., Ph.D. (NYU) *Professor of Spanish and Comparative Literature*
 Kang Liu, Ph.D. (Wisconsin) *Associate Professor of Comparative Literature and Chinese*
 Christiane P. Makward, Docteur es Lettres (Sorbonne) *Associate Professor of French and Comparative Literature*
 John W. Moore, Jr., Ph.D. (Stanford) *Associate Professor of English and Comparative Literature*
 Gerald M. Moser, Docteur es Lettres (Paris) *Professor Emeritus of Romance Languages*
 Philip Mosley, Ph.D. (East Anglia) *Associate Professor of English, Communications, and Comparative Literature*
 Reiko Tachibana, Ph.D. (Penn State) *Associate Professor of Comparative Literature and Japanese*
 Steven Putzel, Ph.D. (Toronto) *Assistant Professor of English*
 Alice Sheppard, Ph.D. (Cornell) *Assistant Professor of English and Comparative Literature*
 Allan Stoekl, Ph.D. (SUNY) *Associate Professor of French and Comparative Literature*
 Gerhard F. Strasser, Ph.D. (Brown) *Professor of German and Comparative Literature*
 Kenneth A. Thigpen, Ph.D. (Indiana) *Associate Professor of English and Comparative Literature*
 Daniel Walden, Ph.D. (NYU) *Professor Emeritus of American Studies, English, and Comparative Literature*
 Adrian Wanner, Ph.D. (Columbia) *Associate Professor of Slavic and Comparative Literature*
 Stanley Weintraub, Ph.D. (Penn State) *Evan Pugh Professor of Arts and Humanities*

Graduate programs in Comparative Literature are designed to permit advanced study in several departments along with integrative courses in the Department of Comparative Literature. Both the M.A. and the Ph.D. combine a core of comparative literature requirements with courses in national literatures and further comparative courses, according to each student's interests. For example, programs of study can concentrate on such topics as genres, themes, periods, movements, folktale and oral literature, criticism, and the links between literature and related fields such as theatre or women's studies.

The M.A. is a general humanistic degree that helps prepare students for a variety of situations, including teaching in private high schools or community colleges, or further graduate work. The Ph.D. is a more specialized degree. The Ph.D. in comparative literature can be combined with a minor in a professional field such as teaching English as a second language.

Only the faculty members and courses officially associated with the Department of Comparative Literature are listed here. Faculty members and courses in other departments are also available to comparative literature students according to their preparation.

Admission Requirements

Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Students with appropriate course backgrounds and a 3.00 junior/senior average (on a 4.00 scale) will be considered for admission. The admission process is highly competitive and the best qualified students will be admitted subject to space availability. Scores from the Graduate Record Examination (GRE) are required for admission. Most students who do graduate work in comparative literature hold a B.A. or M.A. degree in comparative literature or in a national language and literature. Students completing degrees in such fields are welcome to apply—as are students in other humanistic fields, such as philosophy or history, if they have studied literature.

For admission to the M.A. program, students should be prepared to study at least one foreign literature in its own language. For admission to the Ph.D. program, students should be prepared to study at least two foreign literatures in their own language. Doctorate-seeking students usually complete the M.A. before being formally admitted to the Ph.D. program, but exceptional students may be admitted from the B.A. level directly to the Ph.D. Students are encouraged to plan a unified M.A./Ph.D. program if they take both degrees here; however, Ph.D. applications are welcomed from students holding or completing an M.A. elsewhere.

Master's Degree Requirements

Requirements for the M.A. in comparative literature include CMLIT 501; 12 further credits in comparative literature courses; 18 credits divided between two literatures (9 credits in each); a master's paper; and proficiency in two foreign languages (one at the level that permits thorough literary analysis of texts, the other at the level of reading proficiency).

Doctoral Degree Requirements

Requirements for the Ph.D. in comparative literature include (1) CMLIT 501, 502, and 503—with substitute courses if these have been used in the M.A. program; (2) at least an additional 21 credits in literature courses, including course work in the three languages that the student selects, with emphasis on the student's primary literature—students should organize their course work, as much as possible, around a unifying principle, such as genre, period, or theme; (3) an oral candidacy examination; (4) proficiency in three foreign languages; (5) a written comprehensive examination based on a reading list; and (6) a dissertation.

On item (4), two of the foreign languages are to be prepared at a level that permits thorough literary analysis of texts in those languages; the third foreign language may be prepared at reading proficiency only. Upon approval of the department's graduate committee in consultation with an expert in the student's field, an official doctoral minor may be substituted for the reading-proficiency language.

Other Relevant Information

Students pursuing a graduate degree in comparative literature have individualized programs of study within the requirements specified above. For example, one student may emphasize drama; another, the novel. One student may concentrate on earlier literatures; another, on modern. One student may be interested primarily in the European tradition; another, in the New World (or "Inter-American") literatures. In such a program, the relationship between student and adviser is important. Each graduate student works with faculty advisers (a general adviser and a thesis or dissertation adviser) familiar with comparative studies as a whole and with the student's particular area of interest.

Student Aid

Teaching assistantships in the Department of Comparative Literature, as well as in related language and literature departments, typically have been available to students taking comparative literature degrees. In recent years, Comparative Literature students have held assistantships in Arabic, Chinese, English, French, German, Hebrew, Italian, Japanese, Polish, Slavic, Spanish, Swahili, and Women's Studies, as well as in Comparative Literature courses. There also is a graduate assistantship position for an editorial assistant to the journal *Comparative Literature Studies*, which is edited in the department. In addition to the fellowships, graduate assistantships, and other forms of financial aid described in the STUDENT AID section of the *Graduate Bulletin*, the following awards typically have been available to graduate students in this program:

SAMUEL P. BAYARD AWARD—Available annually to a graduate student in comparative literature, selected by the graduate committee of the Department of Comparative Literature. Amount varies.

EDWIN ERLE SPARKS FELLOWSHIPS IN THE HUMANITIES (8)—Available to beginning and continuing graduate students in the following graduate programs: Comparative Literature, English, French, German, History, Philosophy, Spanish, and Speech Communication; stipend \$12,260 plus waiver of tuition. Apply to department before January 1.

FOLGER INSTITUTE FELLOWSHIPS—Penn State is a member of the Folger Institute of Renaissance and Eighteenth-Century Studies. Graduate students in Comparative Literature are eligible for Folger Institute Fellowships to study in seminars and workshops at the Folger Library, Washington, D.C.

COMPARATIVE LITERATURE (CMLIT)

400W. SENIOR SEMINAR IN LITERARY CRITICISM AND THEORY (3)

401W. THE WESTERN LITERARY HERITAGE I (3)

402W. THE WESTERN LITERARY HERITAGE II (3)

404. LITERARY MODES OF ASIA (3)

405. INTER-AMERICAN LITERATURE (3)

406. WOMEN AND WORLD LITERATURE (3)

408. HEROIC LITERATURE (3)

410. PROBLEMS IN TRANSLATION (3)

- 422. AFRICAN DRAMA (3)
- 423. AFRICAN NOVEL (3)
- 443. LITERARY RELATIONS OF GERMANY WITH ENGLAND AND AMERICA (3-9)
- 453. (COMM) NARRATIVE THEORY: FILM AND LITERATURE (3)
- 470. OLD MASTERS OF THE MODERN NOVEL (3)
- 480. THE INTERNATIONAL FOLKTALE (3)
- 481. THEORY AND TECHNIQUES OF WORLD FOLKLORE (3)
- 486. TRAGEDY (3)
- 487. COMEDY (3)
- 488. (ENGL) MODERN CONTINENTAL DRAMA (3)
- 494. RESEARCH PROJECT (1-12)
- 496. INDEPENDENT STUDIES (1-18)
- 497, 498. SPECIAL TOPICS (1-9)
- 499. FOREIGN STUDY—COMPARATIVE LITERATURE (3-6)
- 501. COMPARATIVE METHODS IN LITERARY STUDIES (3) Bibliography, research methods, and studies in comparative literature.
- 502. COMPARATIVE CRITICISM I: CLASSICAL TO NEOCLASSICAL (3) Issues in literary criticism from Plato and Aristotle to the mid-eighteenth century.
- 503. COMPARATIVE CRITICISM II: ROMANTIC TO CONTEMPORARY (3) Principles and theories of literary criticism from eighteenth- and nineteenth-century beginnings to twentieth-century expansion and application.
- 504. STUDIES IN LITERARY GENRES (3-6) The concept of genre and the evolution of genre theory; application to a specific genre, e.g., the lyric or the novel.
- 505. STUDIES IN LITERARY PERIODS AND MOVEMENTS (3-6) Comparative approaches to cohesive units within literary history, e.g., the Renaissance, the Enlightenment, Romanticism, and Surrealism.
- 506. STUDIES IN LITERARY THEMES AND MOTIFS (3-6) Comparative approaches to recurrent literary themes and motifs; application to a specific example, e.g., literary Utopias or the Faust theme.
- 510. THEORY AND PRACTICE OF TRANSLATION (3) Theories of translation and interpretation; importance of translation in literary transmission; application of theoretical concepts to individual translation projects. Prerequisites: 24 credits in a foreign language.
- 543. LITERARY RELATIONS (3 per semester, maximum of 6) Mutual influences among specific literatures and cultures; for example, German-American, French-American, Inter-American, or East-West literary relations.
- 570. FORCES IN CONTEMPORARY LITERATURE (3-6) Intellectual currents and experimental forms in contemporary world literature.
- 580. CONTEMPORARY LITERARY THEORY (3) Major issues in contemporary literary theory and their significance for criticism, with emphasis on continental European theorists and their influence.
- 589. (FR, GER, SPAN) TECHNOLOGY IN FOREIGN LANGUAGE EDUCATION: AN OVERVIEW (3) Approaches to the uses and research applications of multimedia and other educational technologies applied to the teaching of foreign languages.
- 590. COLLOQUIUM (1-3)
- 593. ANGLO-AMERICAN FOLK SONG (3) Survey of relevant literary and ethnological scholarship and field work, European and American, from the early sixteenth century to the present.
- 596. INDIVIDUAL STUDIES (1-9)
- 597. SPECIAL TOPICS (1-9)
- 599. FOREIGN STUDY—COMPARATIVE LITERATURE (1-12) Graduate-level courses offered on comparative literary topics as part of a foreign-study experience approved by the program head. Prerequisites: 24 credits in the appropriate foreign language(s); 18 credits in literature or relevant related fields.

COMPUTER SCIENCE (COMP)

THANG N. BUI, *Graduate Program Coordinator*
 E-258 Olmsted Building
 Penn State Harrisburg
 777 W. Harrisburg Pike
 Middletown, PA 17057-4898
 717-948-6081
 E-mail: tbui@psu.edu

The Graduate Faculty

Thang N. Bui, Ph.D. (MIT) *Associate Professor of Computer Science*

Linda M. Null, Ph.D. (Iowa State) *Assistant Professor of Computer Science*

Winston A. Richards, Ph.D. (Western Ontario) *Associate Professor of Mathematics and Statistics*

M. Susan Richman, Ph.D. (Aberdeen) *Associate Professor of Mathematics and Computer Science*

Clifford H. Wagner, Ph.D. (SUNY at Albany) *Associate Professor of Mathematics and Computer Science*

Timothy A. Wahls, Ph.D. (Iowa State) *Assistant Professor of Computer Science*

Degree Conferred: M.S.

The program is professionally oriented and designed to prepare students for employment in industry or government. Courses emphasize practical concerns as well as the relevant theoretical background. The program will provide appropriate background for diverse tasks such as developing scientific and engineering applications, developing system software, developing safety or security critical systems, solving computationally hard problems, and developing distributed applications. While not intended as preparation for subsequent entrance to a Ph.D. program, this goal is not precluded. Once the specific course requirements are met, appropriate selection of electives will enable individual interests to be met within the program. Anticipated areas of interest include software engineering, systems programming, and artificial intelligence.

Admission Requirements

In addition to the general Graduate School requirements, applicants must present a baccalaureate degree in Computer Science or a related field from an accredited institution. A minimum GPA of 2.75 (on a 4.0 scale) is required. While a bachelor's degree in Computer Science is not required, admission without deficiency requires that an applicant has completed courses in analysis of algorithms, operating systems, database, and linear algebra. If these courses are not taken before admission to the program, they may be taken at Penn State Harrisburg, but the student will receive at most 3 credits toward the M.S. degree for these courses.

At the discretion of the program, applicants may be required to provide scores from the Graduate Record Exam (GRE) and/or the GRE subject test in computer science. In addition, applicants must provide three letters of reference, at least one of which is from an academic source, and a letter outlining significant work experience and academic and career objectives.

Degree Requirements

A total of 30 graduate credits (400-level or above) is required for the degree of master of science in Computer Science, with a minimum of 18 of these credits at the 500 level. A minimum grade-point average of 3.0 must be earned for course work taken as a graduate student. Students are required to take the following courses: MA SC 505, COMP 511, 512, 519, 580. Students who believe that they have completed a course substantially similar to one of the specific course requirements may apply to have their previous work evaluated for the purpose of exemption to that requirement. If the exemption is granted, another approved course shall be taken in place of that required course. Students are required to complete the remaining 15 credits with program approved electives in computer science, mathematics, engineering, and information systems courses. A maximum of 9 transfer credits will be allowed for course work completed as a graduate student at another institution.

Suggested Tracks

For students with interests in the areas of software engineering, systems programming, and artificial intelligence, the program suggests the following course work. These tracks are only advisory—there is no requirement that a student follow any track, and tracks will not be noted on diplomas or transcripts.

Track in Software Engineering: Students following the track in software engineering will be provided with the conceptual tools needed for designing and managing large software systems. In addition to the required core, the track in software engineering consists of the following courses: COMP 513, 516, INFSY 570. In addition to these courses, COMP 418 is highly recommended, as compiler development is an ideal environment for gaining practical experience with software engineering techniques and tools.

Track in Systems Programming: Students following the track in systems programming will receive instruction in both the conceptual foundation of systems software and the implementation of such systems. In addition to the required core, the track in systems programming consists of the following courses: COMP 421, 517, 545.

Track in Artificial Intelligence: Students following the track in artificial intelligence are expected to gain an understanding in the theory and applications of AI methods as well as evolutionary methods for solving a variety of problems. In addition to the required core, the track in artificial intelligence consists of the following courses: COMP 520, 524, 556.

Additional Information

See the program Web page at URL <http://cs.hgb.psu.edu/>

COMPUTER SCIENCE (COMP)

402. COMPUTER ORGANIZATION AND ASSEMBLY LANGUAGE (3)

403. ADVANCED ASSEMBLY (3)

406. COMPUTER GRAPHICS I (3)

407. STRUCTURED PROGRAMMING WITH PASCAL (3)

408. INTRODUCTORY ADA AND PROGRAM DESIGN (3)

409. ADVANCED ADA PROGRAMMING LANGUAGE (3)

410. DATA STRUCTURES (3)

411. ANALYSIS OF COMPUTER ALGORITHMS (3)

412. OPERATING SYSTEMS I (3)

413. SOFTWARE ENGINEER DESIGN (3)

414. SYSTEMS SIMULATION (3)

416. TOPICS IN PROGRAMMING LANGUAGE (3)

418. COMPILER CONSTRUCTION (3)

419. DATABASE DESIGN I (3)

420. ARTIFICIAL INTELLIGENCE I (3)

421. COMMUNICATIONS AND NETWORKING (3)

425. ADVANCED OPERATING SYSTEMS (3)

430. UNIX AND C (3)

432. PROGRAMMING WITH C++ (3)

435. OOD ADA/C++ (3)

497. SPECIAL TOPICS(1-9)

511. DESIGN AND ANALYSIS OF ALGORITHMS (3) Amortized analysis, graph algorithms, NP-complete problems, approximation algorithms, parallel algorithms. Prerequisites: COMP 411, MA SC 505.

512. ADVANCED OPERATING SYSTEMS (3) A study of the principles and practice of distributed system design, including communication, synchronization, processes, file systems, and memory management. Prerequisite: COMP 412.

513. FORMAL METHODS FOR SOFTWARE ENGINEERING (3) Object-oriented software development, formal specification techniques and related CASE tools, software reuse, verification and validation, transformational development. Prerequisite: COMP 413, 511, or permission of the program.

516. ADVANCED PROGRAMMING LANGUAGES (3) Programming paradigms and styles, object-oriented programming, formal semantics, programming language design. Prerequisite: COMP 416.

517. COMPUTER SECURITY (3) Introduction to the area of computer security and current issues associated with computer security. Prerequisite: MA SC 370.

519. ADVANCED TOPICS IN DATABASE MANAGEMENT SYSTEMS (3) Concurrency control, crash recovery, query processing, semantic data models, advanced file access, distributed database systems, performance, case studies, advanced applications. Prerequisites: COMP 419, MA SC 370.

520. ADVANCED ARTIFICIAL INTELLIGENCE (3) Problem solving, knowledge representation, language understanding, perception, learning, artificial neural networks. Prerequisite: COMP 511 or permission of the program.

524. EVOLUTIONARY COMPUTATION (3) Topics in evolutionary algorithms and genetic algorithms. Prerequisite: COMP 511 or permission of the program.

545. COMPUTER ARCHITECTURE (3) Cache, pipelining, memory design, interconnection networks, multiprocessor systems. Prerequisite: COMP 402.

556. NEURONAL COMPUTATION (3) Anatomy and physiology of neurons, artificial neural elements, computational neural models, neural image processing, pattern recognition, and computation. Prerequisites: COMP 430, MA SC 460.

580. MASTER'S PROJECT (3 per semester/maximum of 6) Research into a specific computer science problem, development of a scholarly written paper, and oral defense of the work. Prerequisite: permission of the program.

591. TOPICS IN COMPUTER SCIENCE (1–3 per semester/maximum of 6) Study of topics in computer science. Prerequisite: permission of the program.

COMPUTER SCIENCE AND ENGINEERING (CSE)

DALE A. MILLER, *Head of the Department*
220 Pond Laboratory
814-865-9505

Degrees Conferred: Ph.D., M.S., M.Eng.

The Graduate Faculty

Jesse Barlow, Ph.D. (Northwestern) *Professor of Computer Science and Engineering*
Piotr Berman, Ph.D. (MIT) *Associate Professor of Computer Science and Engineering*
Octavia Camps, Ph.D. (Washington) *Assistant Professor of Computer Science and Engineering and Electrical Engineering*
Lee D. Coraor, Ph.D. (Iowa) *Associate Professor of Computer Science and Engineering*
Chitaranjan Das, Ph.D. (S.W. Louisiana) *Professor of Computer Science and Engineering*
Tse-yun Feng, Ph.D. (Michigan) *Professor of Computer Science and Engineering*
Martin Fürer, Dr.Sc.Math. (ETH—Zurich) *Associate Professor of Computer Science and Engineering*
Jonathan Goldstine, Ph.D. (California, Berkeley) *Associate Professor of Computer Science and Engineering*
Dima Grigoriev, Ph.D. (Moscow) *Professor of Computer Science and Engineering*
John Hannan, Ph.D. (Pennsylvania) *Assistant Professor of Computer Science and Engineering*
Ali R. Hurson, Ph.D. (Central Florida) *Associate Professor of Computer Engineering*
Mary Jane Irwin, Ph.D. (Illinois) *Professor of Computer Science and Engineering*
Gerald G. Johnson, Jr., Ph.D. (Penn State) *Associate Professor of Computer Science and Engineering*
Rangachar Kasturi, Ph.D. (Texas Tech.) *Professor of Computer Science and Engineering*
Thomas F. Keefe, Ph.D. (Minnesota) *Associate Professor of Computer Science and Engineering*
Joseph M. Lambert, Ph.D. (Purdue) *Associate Professor of Computer Science and Engineering*
John J. Metzner, Ph.D. (New York) *Professor of Computer Science and Engineering*
Webb Miller, Ph.D. (Washington) *Professor of Computer Science and Engineering*
Simin H. Pakzad, Ph.D. (Oklahoma) *Associate Professor of Computer Science and Engineering*
Catuscia Palamidessi, Ph.D. (Pisa, Italy) *Professor of Computer Science and Engineering*
Paul Plassmann, Ph.D. (Cornell) *Assistant Professor of Computer Science and Engineering*
Rajeev Sharma, Ph.D. (Maryland) *Assistant Professor of Computer Science and Engineering*
Anand Sivasubramaniam, Ph.D. (Georgia Tech) *Assistant Professor of Computer Science and Engineering*
Hongyuan Zha, Ph.D. (Stanford) *Assistant Professor of Computer Science and Engineering*

The department offers courses and is prepared to direct research in a variety of subfields of computer science and engineering, including VLSI, computer architecture, parallel/distributed processors and processing, multiprocessors, interconnection networks, pattern recognition and image processing, performance evaluation, reliability, fault tolerance, theory of computation, computer systems, numerical analysis and optimization, programming methodology, and analysis of algorithms. Research and instruction are supported by extensive computing facilities in the University's Center for Academic Computing and by the computer laboratories operated by the department.

For information about areas of specialization, laboratory and research facilities, fellowships assistantships, and other sources of financial assistance, write to the Graduate Office, Department of Computer Science and Engineering, The Pennsylvania State University, 201A Pond Laboratory, University Park, PA 16802-2705.

Admission Requirements

All applicants must provide a one-page statement of purpose and scores from the General Record Examination (GRE). A subject test in the GRE is not required but the subject test in Computer Science or Engineering is recommended.

Master's Degree Requirements

Candidates for the master's degree must satisfactorily complete the requirements of the Graduate School. In addition, all students are expected to have completed appropriate courses in computer architecture and

machine organization, data structures and analysis of algorithms, programming languages, operating systems, and logical design/switching theory or theory of automata. Students who do not meet background requirements will be required to take the appropriate 400-level courses to prepare them for the 500-level courses. At most, 3 credits of background course work can be used to satisfy the degree requirements.

Master of science students must take 15 credits of courses with numbers CSE 500 through 589, including a minimum of 9 credits of breadth courses taken from the department's Graduate Handbook in Computer Science and Engineering. An additional 9 credits of graduate-level courses (excluding independent studies courses) are required (see Handbook). This must include at least 1, and at most 2 credits, of CSE 590 (colloquium). Students must complete and defend an M.S. thesis (6 credits of CSE 600). The total degree requirement is 30 credits.

Master of engineering students must take 18 credits of courses with numbers 500 through 589, with at least 15 of the credits being associated with courses that have CSE designations (including a minimum of 9 credits of breadth courses referenced above). Students must also take 12 additional credits of graduate-level courses, excluding independent studies courses (see Handbook). This must include at least 1, and at most 2, credits of CSE 590 (colloquium). Students are required to complete and defend a 1-credit technical paper (CSE 594). The total degree requirement is 30 credits.

Doctoral Degree Requirements

The doctoral degree requirements include the general requirements of the Graduate School as listed under Doctoral Degree Requirements. To qualify for a Ph.D. degree, each student must take 27 credits of courses with numbers CSE 500 through 589 and 21 additional credits of nonthesis graduate courses. The 21 additional credits must include at least 3 credits of CSE 590 (colloquium), with a maximum of 3 credits of CSE 590 being counted toward the total of 48 minimum credits. A maximum of 3 credits of X96 may also be counted. A student must pass the Ph.D. candidacy examination by the third regular semester after entering the program (see Handbook). Students must pass the Ph.D. comprehensive examination after completion of most of the course work, and the English competency and communication requirements. A thesis must be completed under the direction of a Ph.D. committee and the results must be successfully defended in the thesis defense examination.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

COMPUTER SCIENCE AND ENGINEERING (CSE)

- 411. OPERATING SYSTEMS (3)
- 412. MICROCOMPUTER LABORATORY (3)
- 413. PROJECTS IN COMPUTER SYSTEMS (3)
- 418. COMPUTER GRAPHICS (3)
- 420W. SOFTWARE DESIGN METHODS (3)
- 421. INTRODUCTION TO COMPILER CONSTRUCTION (3)
- 428. PROGRAMMING LANGUAGE CONCEPTS (3)
- 430W. COMPUTER ENGINEERING PROJECT DESIGN (3)
- 431. INTRODUCTION TO COMPUTER ARCHITECTURE (3)
- 441W. INTRODUCTION TO DATABASE MANAGEMENT SYSTEMS (3)
- 447. (E E) DIGITAL INTEGRATED CIRCUITS (3)
- 451. (MATH) NUMERICAL COMPUTATIONS (3)
- 455. (MATH) INTRODUCTION TO NUMERICAL ANALYSIS I (3)
- 456. (MATH) INTRODUCTION TO NUMERICAL ANALYSIS II (3)
- 457. CONCURRENT SCIENTIFIC COMPUTING (3)
- 458. (E E) DATA COMMUNICATIONS (3)
- 460. COMBINATORICS AND GRAPH THEORY (3)
- 465. DATA STRUCTURES AND ALGORITHMS (3)
- 467. (MATH) FACTORIZATION AND PRIMALITY TESTING (3)
- 468. THEORY OF AUTOMATA, LANGUAGES, AND COMPUTABILITY (3)
- 471. LOGICAL DESIGN OF DIGITAL SYSTEMS (3)
- 477. VLSI DIGITAL CIRCUITS (3)
- 481. INTRODUCTION TO ARTIFICIAL INTELLIGENCE I (3)
- 485. (E E) DIGITAL IMAGE PROCESSING (3)
- 486. (E E) FUNDAMENTALS OF COMPUTER VISION (3)
- 494. SENIOR THESIS (1-9)

496. INDEPENDENT STUDIES (1–18)

497, 498. SPECIAL TOPICS (1–9)

511. OPERATING SYSTEM DESIGN (3) Concurrent programming; design of I/O subsystem, memory management, and user interface; kernel design; deadlocks, protection and security; case studies. Prerequisite: CSE 411.

512. DIGITAL SYSTEM DESIGN (3) Complete digital system design, including specification, internal organization, and realization. Discussion of interaction among digital systems and subsystems. Prerequisite: CSE 412.

513. DISTRIBUTED SYSTEMS (3) Protocol hierarchies; routing and flow control algorithms; distributed operating systems; communication and synchronization mechanisms; resource allocation problems. Prerequisite: CSE 511.

514. COMPUTER NETWORKS (3) Network subsystems, ARPANET, SNA, DECNET, network protocols (physical databank, network, transport, sessions, presentation, application), routing and congestion control, network optimization. Prerequisite: graduate standing.

517. PERFORMANCE EVALUATION (3) Tools and techniques for PE, analytical and simulation models, evaluation of multiprocessors, multicomputer and LANs, scheduling policies, case studies. Prerequisite: graduate standing.

520. SCIENCE OF COMPUTER PROGRAMMING (4) Weakest preconditions, nondeterminism, terminating constructs, formal derivation of some often used algorithms, correctness of programs, formal specification of large systems.

521. COMPILER CONSTRUCTION (3) Design and implementation of compilers. Prerequisite: CSE 465.

522. SEMANTICS OF PROGRAMMING LANGUAGES (3) Operational, axiomatic, and denotational semantics of programming languages; fixpoint theory of computation, verification of recursive programs; goto statements and continuations.

530. FUNDAMENTALS OF COMPUTER ARCHITECTURE (3) Advances in computer architecture, Pipelining, parallelism, and multiprocessing. Prerequisite: CSE 431.

531. PARALLEL PROCESSORS AND PROCESSING (3) Parallel processor organization; basic algorithms suitable for such systems; parallel sorting and interconnection networks; applications and discussion of specific processors. Prerequisite: CSE 530.

532. MULTIPROCESSOR ARCHITECTURE (3) Fundamental structures of multiprocessors; inter-process communications; system deadlocks and protection, scheduling strategies, and parallel algorithms; example multiprocessor systems. Prerequisite: CSE 530.

533. UNCONVENTIONAL MACHINE ARCHITECTURE (3) Shortcomings of the Von-Neumann model; resolution of those shortcomings; architectural effects of these solutions; effects of technological advances. Prerequisite: CSE 530.

536. FAULT TOLERANT SYSTEMS (3) Attributes of fault-tolerant systems and their definitions; reliability and availability techniques; maintainability and testing techniques; practice of reliable system design. Prerequisite: CSE 530.

537. INTERCONNECTION NETWORKS IN HIGHLY PARALLEL COMPUTERS (3) Study and comparative analysis of various classes of interconnection networks, routing problems, fault tolerance issues, performance evaluation, VLSI implementation. Prerequisite: CSE 530.

539. TOPICS IN COMPUTER ARCHITECTURE (3) Study of current advanced issues in design, implementation and applications of complex computer systems. Prerequisite: CSE 530.

541. DATABASE SYSTEMS I (3) Data models and relational database design; database integrity and concurrency control; distributed database design and concurrency control; query optimization. Prerequisite: CSE 465 or 565.

542. DATABASE SYSTEMS I (3) Important in-depth issues relating to data engineering, such as distributed databases, information management for engineering design, data models. Prerequisite: CSE 541.

543. COMPUTER SECURITY (3) Specification and design of secure systems; security models, architectural issues, verification and validation, and applications in secure database management systems. Prerequisite: CSE 428.

550. (MATH) NUMERICAL LINEAR ALGEBRA (3) Solution of linear systems, sparse matrix techniques, linear least squares, singular value decomposition, numerical computation of eigenvalues and eigenvectors. Prerequisite: CSE 456 or MATH 441.

551. (MATH) NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS (3) Methods for initial value and boundary value problems. Convergence and stability analysis, automatic error control, stiff systems, and boundary value problems. Prerequisites: CSE (MATH) 451 or 456.

552. (MATH) NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS (3) Finite difference methods for elliptic, parabolic, and hyperbolic differential equations; solutions techniques for

discretized systems; finite element methods for elliptic problems. Prerequisites: CSE 451 or 456; MATH 402 or 404.

553. (MATH) INTRODUCTION TO APPROXIMATION THEORY (3) Interpolation; remainder theory; approximation of functions; error analysis; orthogonal polynomials; approximation of linear functionals; functional analysis applied to numerical analysis. Prerequisites: MATH 401; 3 credits in CSE.

554. (E E) ERROR CORRECTING CODES FOR COMPUTERS AND COMMUNICATION (3) Block, cyclic, and convolutional codes. Circuits and algorithms for decoding. Application to reliable communication and fault-tolerant computing. Prerequisite: CSE 458.

555. (MATH) NUMERICAL OPTIMIZATION TECHNIQUES (3) Unconstrained and constrained optimization methods, linear and quadratic programming, software issues, ellipsoid and Karmarkar's algorithm, global optimization, parallelism in optimization. Prerequisite: CSE (MATH) 456.

556. (MATH) FINITE ELEMENT METHODS (3) Sobolev spaces, variational formulations of boundary value problems; piecewise polynomial approximation theory, convergence and stability, special methods and applications. Prerequisites: MATH 502, 552.

557. CONCURRENT MATRIX COMPUTATION (3) This course discusses matrix computations on architectures that exploit concurrency. It will draw upon recent research in the field. Prerequisites: CSE (MATH) 451, 455, and CSE 457.

560. THEORY OF GRAPHS AND NETWORKS (3) Theory and applications of graphs, including structure of graphs, network analysis, and algorithms for computer solution of graph-theoretic problems. Prerequisite: CSE 565.

561. SEQUENTIAL AND PARALLEL COMPLEXITY THEORY (3) Models of sequential and parallel computers; relationships between complexity measures; simulations and universality; resource-bounded hierarchies; lower-bound techniques. Prerequisite: CSE 468.

562. PROBABILISTIC ALGORITHMS (3) Design and analysis of probabilistic algorithms, reliability problems, probabilistic complexity classes, lower bounds. Prerequisite: CSE 565.

563. PARALLEL ALGORITHMS (3) Computational aspects of VLSI: synthesis/analysis of efficient parallel and distributed algorithms; computational structures; models of parallel computers and their interrelationships. Prerequisite: CSE 565.

564. COMPLEXITY OF COMBINATORIAL PROBLEMS (3) NP-completeness theory; approximation and heuristic techniques; discrete scheduling; additional complexity classes. Prerequisite: CSE 565.

565. ALGORITHMIC DESIGN AND ANALYSIS (3) An introduction to algorithmic design and analysis. Prerequisite: CSE 465.

568. THEORY OF FORMAL LANGUAGES AND AUTOMATA (3) Generation and recognition of formal languages, grammars, Chomsky's hierarchy of languages, closure properties, characterization by automata, algebraic properties, complexity classification. Prerequisite: CSE 468.

571. SWITCHING AND SEQUENTIAL MACHINE THEORY (3) Advanced treatment of switching and machine theory, minimization of machines, state assignment, hazard analysis. Prerequisite: CSE 471.

575. ARCHITECTURE OF ARITHMETIC PROCESSORS (3) Algorithms and techniques for designing arithmetic processors; conventional algorithms and processor design; high-speed algorithms and resulting architectural structures. Prerequisites: CSE 431, 477.

577. VLSI SYSTEMS DESIGN (3) Engineering design of large-scale integrated circuits, systems, and applications; study of advanced design techniques, architectures, and CAD methodologies. Prerequisite: CSE 477.

578. VLSI COMPUTER-AIDED DESIGN TOOLS (3) VLSI circuit design tools: placement, routing, extraction, design rule checking, graphic editors, simulation, verification, minimization, silicon compilation, test pattern generation. Prerequisite: CSE 477.

581. PATTERN RECOGNITION—PRINCIPLES AND APPLICATIONS (3) Decision-theoretic classification, discriminant functions, pattern processing and feature selection, syntactic pattern recognition, shape analysis and recognition.

585. (E E) DIGITAL IMAGE PROCESSING II (3) Advanced treatment of image processing techniques; image restoration; image segmentation, texture, and mathematical morphology. Prerequisite: CSE (E E) 485.

586. (E E) TOPICS IN COMPUTER VISION (3) Discussion of recent advances and current research trends in computer vision theory, algorithms, and their applications. Prerequisite: CSE (E E) 486.

588. (MATH) COMPLEXITY IN COMPUTER ALGEBRA (3) Complexity of integer multiplication, polynomial multiplication, fast Fourier transform, division, and calculating the greatest common divisor of polynomials. Prerequisite: CSE 465.

590. COLLOQUIUM (1–3)

591. RESEARCH EXPERIENCE IN COMPUTER SCIENCE AND ENGINEERING (1) Research experience for new doctoral students in computer science and engineering. Research is performed in

COUNSELING PSYCHOLOGY

conjunction with another 500-level CSE course. Concurrent: enrollment in another 500-level CSE course.
594. RESEARCH TOPICS (1–15)
596. INDIVIDUAL STUDIES (1–9)
597. SPECIAL TOPICS (1–9)
598. SPECIAL TOPICS (1–9)

COUNSELING PSYCHOLOGY (CNPSY)

KATHLEEN J. BIESCHKE, *In Charge of Graduate Program in Counseling Psychology*
327 CEDAR Building
814-863-7536

Degree Conferred: Ph.D.

The Graduate Faculty

Kathleen J. Bieschke, Ph.D. (Michigan State) *Associate Professor of Counseling Psychology*
Jeffrey A. Hayes, Ph.D. (Maryland) *Assistant Professor of Education*
Dennis E. Heitzmann, Ph.D. (Texas) *Affiliate Associate Professor of Counseling Psychology*
Edwin L. Herr, Ed.D. (Columbia) *Distinguished Professor of Education*
Joyce K. Illfelder-Kaye, Ph.D. (Ohio State) *Affiliate Assistant Professor of Counseling Psychology*
Donald B. Keat II, Ph.D. (Temple) *Professor of Education and Counseling Psychology*
Jack R. Rayman, Ph.D. (Iowa) *Affiliate Professor of Education and Counseling Psychology*
Robert B. Slaney, Ph.D. (Ohio State) *Professor of Counseling Psychology*
John Swisher, Ph.D. (Ohio State) *Professor of Education*
Beverly Vandiver, Ph.D. (Ball State) *Assistant Professor of Education*

The Ph.D. in Counseling Psychology is fully approved by the American Psychological Association and approved by the Pennsylvania Board of Psychologist Examiners. This degree program is designed to train counseling psychologists in the scientist-practitioner model. Graduates of this program are automatically entitled to sit for the psychology licensure examination in Pennsylvania and in most other states. Requirements vary from state to state so students desiring licensure in other states must determine the requirements of the state in which they intend to practice, although graduation from an A.P.A.-approved doctoral training program in counseling psychology is ordinarily sufficient to qualify to sit for a state licensure examination as a psychologist.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

All candidates for the Ph.D. in Counseling Psychology must present a master's degree program, the content of which is relevant to counseling psychology (e.g., rehabilitation counseling, counselor education, clinical or general psychology). Doctoral candidates should present a 3.33 average in all graduate study completed.

Degree Requirements

In addition to academic competence, all candidates are expected to exhibit effectiveness in interpersonal relations and in both written and oral communication. They also must evidence support of professional counseling activities and organizations.

Ph.D. students in Counseling Psychology must satisfy degree requirements in statistics and research design, general psychology foundations, and a counseling specialty area. In addition, students participate in extensive practicum, clinic team, and internship experiences under supervision. As part of the requirements for the Ph.D., all students must complete an approved internship in a counseling center or other facility meeting criteria set by the American Psychological Association.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by a comprehensive knowledge of one foreign language and courses from other designated areas, or by options from designated areas selected to include competence in statistics, research design, computer application, or measurement.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

COUNSELING PSYCHOLOGY (CNPSY)

497, 498. SPECIAL TOPICS (1–9)

502. ADVANCED COUNSELING THEORY AND METHOD (3) Assessment, intervention, and evaluation procedures for counseling problems frequently encountered in school, college, and rehabilitation settings. Prerequisite: CN ED 501.

503. CURRENT TOPICS IN COUNSELING PSYCHOLOGY (2) Presentation, readings, and discussion of treatment issues; unique concerns of client groups and professional issues that counselors should consider.

511. (HD FS) MODIFYING CONJUGAL LIFE (1–9) Conceptual foundations, research procedures, and practicum experience in teaching effective communication and problem-solving skills in the marriage relationship. Prerequisites: 6 credits in individual development or psychology and 3 credits in statistics.

512. (HD FS) FILIAL RELATIONSHIP MODIFICATION (1–9) Theory, research, and practicum in teaching parents to resolve developmental problems in their own children. Prerequisites: 6 credits in individual development or psychology and 3 credits in statistics.

554. CROSS-CULTURAL COUNSELING (3) Examines theory, research, and models of counseling relationships between counselors and clients of different racial and sociocultural backgrounds. Prerequisites: CN ED 507, 595A, or CNPSY 595A.

555. CAREER COUNSELING (3) The examination of historical, legislative, and current models of career counseling and the development of pertinent individual and group techniques. Prerequisite: CN ED 505.

589. (CN ED) SEMINAR ON COUNSELING SUPERVISION (1) Study of research about and theoretical models of clinical supervision of counselors. Includes preparation for a practicum in counseling supervision. Prerequisites: CN ED 595A or 595B or practicum; available only to doctoral-level majors in CN ED and CNPSY.

591. SEMINAR IN COUNSELING: HISTORY AND TRENDS (1) Discussion of the history of guidance and counseling, emphasizing how the past has shaped the present and portends the future. Prerequisites: 9 credits in counselor education.

592. LEGAL AND ETHICAL ISSUES IN COUNSELING (3) Study and discussion of legal, ethical, and professional concerns of counselors; philosophical underpinnings; and models of ethical decision making. Prerequisite: 9 credits in counseling psychology.

593. SEMINAR IN COUNSELING: PHILOSOPHY (1) Study and discussion of such philosophical foundations of counseling as phenomenology, idealism, realism, existentialism, daseinanalytic, theological, and other contemporary thoughts. Prerequisites: 9 credits in counselor education.

594. RESEARCH IN COUNSELING (2–6) The design, implementation, and evaluation of counseling research projects. Prerequisites: CN ED 425, 501, 505. Prerequisite or concurrent: EDPSY 506.

595A. COUNSELING PSYCHOLOGY PRACTICUM (1–3 per semester, maximum of 12) Practice in the application of counseling psychology principles and methods to cases counseled under supervision; case conferences. Prerequisites: CN ED 425, 505, 506; available only to CNPSY majors.

595D. (CN ED) SUPERVISION OF COUNSELORS (3–9) Practical experience in supervising and evaluating work of counselors. Prerequisites: CN ED 595A or 595B; available only to majors in CN ED and CNPSY.

596. INDIVIDUAL STUDIES (1–9)

597. SPECIAL TOPICS (1–9)

COUNSELOR EDUCATION (CN ED)

JOHN SWISHER, *In Charge of Graduate Programs in Counselor Education*
327 CEDAR Building
814-865-3428

Degrees Conferred: D.Ed., M.S., M.Ed.

The Graduate Faculty

James A. Barnes, D.Ed. (Penn State) *Assistant Professor of Education*

Nancy E. Clarke, Ph.D. (Michigan State) *Assistant Professor of Education*

COUNSELOR EDUCATION

John R. Culbreth, Ph.D. (North Carolina) *Assistant Professor of Education*
James T. Herbert, Ph.D. (Wisconsin, Madison) *Associate Professor of Education*
Edwin L. Herr, Ed.D. (Columbia) *Distinguished Professor of Education*
Brandon Hunt, Ph.D. (Virginia) *Associate Professor of Education*
W. Terrell Jones, D.Ed. (Penn State) *Affiliate Assistant Professor of Counselor Education*
Donald B. Keat II, Ph.D. (Temple) *Professor of Education and Counseling Psychology*
Jack R. Rayman, Ph.D. (Iowa) *Affiliate Professor of Education and Counseling Psychology*
Daniel Salter, Ph.D. (Ohio State) *Assistant Professor of Education*
Robert E. Shute, D.Ed. (Penn State) *Associate Professor of Education*
John D. Swisher, Ph.D. (Ohio State) *Professor of Education*
Michael J. Taleff, Ph.D. (Pittsburgh) *Assistant Professor of Education*
Janice D. Taylor, Ph.D. (Georgia) *Assistant Professor of Education*
Eric R. White, Ed.D. (Pennsylvania) *Affiliate Assistant Professor of Education*
Keith B. Wilson, Ph.D. (Ohio State) *Assistant Professor of Education*

Professional preparation is offered at the master's level for school counselors (elementary and secondary), college counselors or persons entering college student personnel services, chemical dependency counselors, and rehabilitation counselors. Credits required by different master's options vary from 32 to 54. The doctoral program prepares candidates for positions of responsibility and leadership in these same areas, as well as in the education of counselors and the management and supervision of counseling services.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

All candidates for graduate degrees in Counselor Education must present for admission at least 27 undergraduate credits of 3.00 or better distributed among at least three of the following areas: economics, education, psychology, sociology, and physiology or anatomy.

Students with a 2.50 junior/senior average (on a scale of 4.00) and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests. Doctoral candidates should present at least a 3.33 average in all graduate study completed.

Degree Requirements

All candidates are expected to exhibit, in addition to academic competence, effectiveness in interpersonal relations and in both written and oral communication. They also must evidence support of professional counseling activities and organizations. All degree options require students to participate in extensive practicum or field work experience under supervision.

D.Ed. students in Counselor Education must satisfy degree requirements in empirical foundations, career guidance; administration, planning, and management in service delivery settings; and a minor field of study.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

COUNSELOR EDUCATION (CN ED)

- 401. FOUNDATIONS OF CHEMICAL DEPENDENCY COUNSELING (3)
- 403. FOUNDATIONS OF GUIDANCE AND COUNSELING PROCESSES (3)
- 404. GROUP PROCEDURES IN GUIDANCE AND COUNSELING (3)
- 407. INTRODUCTION TO VOCATIONAL REHABILITATION IN EMPLOYEE COUNSELING (3)
- 408. INTRODUCTION TO VOCATIONAL REHABILITATION (3)
- 409. MEDICAL INFORMATION FOR COUNSELORS (3)
- 410. PSYCHIATRIC REHABILITATION (3)
- 412. REHABILITATION FACILITIES AND SERVICES (3)
- 413W. REHABILITATION CASE RECORDING AND MANAGEMENT (3)
- 414. REHABILITATION FACILITIES AND SERVICES IN INDUSTRIAL SETTINGS (3)
- 415. COUNSELING ADULTS (3)

416. INTERPERSONAL RELATIONSHIPS AND ALCOHOL AND OTHER DRUGS (AOD) DEPENDENCY (3)
420. CHEMICAL DEPENDENCY: YOUTH AT RISK (3)
421. COUNSELING STRATEGIES FOR PREVENTING CHEMICAL DEPENDENCY (3)
423. STUDENT ASSISTANCE PROGRAMS (3)
425. THE USE OF TESTS IN COUNSELING (3)
470. WORKSHOP IN STUDIES IN COUNSELOR EDUCATION (1–6)
490. SEMINAR ON REHABILITATION COUNSELING IN EMPLOYEE ASSISTANCE PROGRAMS (3)
- 495A. FIELD WORK IN VOCATIONAL HABILITATION (15)
496. INDEPENDENT STUDIES (1–18)
- 497, 498. SPECIAL TOPICS (1–9)
501. COUNSELING THEORY AND METHOD (3) Survey of psychodynamic, humanistic, behavioral, and cognitive-behavioral approaches to counseling individuals.
503. GUIDANCE SERVICES IN ELEMENTARY EDUCATION (3) Guidance services to elementary school students; guidance opportunities for elementary teachers and principals.
504. GUIDANCE SERVICES IN SECONDARY EDUCATION (3) Nature and scope of guidance in secondary schools—services, models, and strategies; the counselor as an agent of change.
505. FOUNDATIONS OF CAREER DEVELOPMENT AND COUNSELING INFORMATION (3) Accelerating change in economic, psychological, social, educational influences upon counselees. Utilization of information systems in effecting counselee change.
506. INDIVIDUAL COUNSELING PROCEDURES (3) Training in listening, responding, challenging skills, and action-oriented techniques for individual counseling. Prerequisite: CN ED 501; available only to majors in CN ED and CNPSY.
507. MULTICULTURAL COUNSELING: FOUNDATIONS (3) Provide foundational information that controverts, complements, and extends traditional psychology and counseling theory and practice. Prerequisites: CN ED 404, 501, 506.
508. ORGANIZATION AND ADMINISTRATION OF PUPIL SERVICES (3) Principles, organization, personnel, functions, integration with school programs, evaluation. Prerequisite: A GPA of 3.00 or better in 27 credits or previous course work covering any three of the following five areas: economics, sociology, psychology, education, and anatomy and physiology.
551. STUDENT PERSONNEL SERVICES (2–3) Student personnel services in higher education; organization of student advisory programs; use of personnel data; co-curricular activities; student welfare.
553. STUDENT PERSONNEL SERVICES PROGRAMMING (2–3) Formulation of policies as guides to the student personnel service programs; integration of program elements; research; current problems and trends. Prerequisite: CN ED 551.
560. PSYCHOSOCIAL ASPECTS OF DISABILITY (3) Psychological models of reaction to disability and social consequences in adulthood; generalizations to other life crises; implications for counselor interventions. Prerequisites: 9 credits in counselor education or related area.
561. JOB DEVELOPMENT AND PLACEMENT FOR THE HANDICAPPED (3) Assessing client readiness for work; job-seeking skills training; job placement strategies; modifications to the worksite; methods for employer development. Prerequisites: CN ED 408, 425.
562. CURRENT ISSUES IN REHABILITATION COUNSELING (3) Forum for advanced graduate students in rehabilitation counseling and related fields to discuss, review, analyze current trends in rehabilitation. Prerequisite: available only to majors in Counselor Education or Counseling Psychology.
589. (CNPSY) SEMINAR ON COUNSELING SUPERVISION (1) Study of research about and theoretical models of clinical supervision of counselors. Includes preparation for a practicum in counseling supervision. Prerequisites: CN ED 595A or 595B or practicum; available only to doctoral-level majors in CN ED and CNPSY.
- 595A. COUNSELING PRACTICUM (1–6) Practice in the application of guidance principles and methods to cases counseled under supervision; case conferences; seminar in guidance techniques. Prerequisites: CN ED 425, 505, 506; available only to majors in CN ED and CNPSY.
- 595B. SUPERVISED PRACTICUM IN REHABILITATION COUNSELING (1–6) Application of principles and techniques of rehabilitation counseling to cases involving handicapped individuals. Prerequisites: CN ED 408, 425, 505, 506; available only to majors in CN ED and CNPSY.
- 595C. PROFESSIONAL EXPERIENCE IN REHABILITATION COUNSELING (1–15) Supervised internship, with responsibility for a regular case load. Prerequisites: CN ED 409, 595B; available only to majors in CN ED and CNPSY.

CRIME, LAW, AND JUSTICE

595D. (CNPSY) SUPERVISION OF COUNSELORS (3–9) Practical experience in supervising and evaluating work of counselors. Prerequisite: CN ED 595A or 595B; available to majors in CN ED and CNPSY.

595E. ELEMENTARY SCHOOL COUNSELING INTERNSHIP AND SEMINAR (1–3 per semester, maximum of 6) Off-campus, supervised internships in elementary school settings with supplementary related topics, discussion, and skills training in on-campus seminars. Prerequisite or concurrent: CN ED 503; available only to majors in CN ED and CNPSY.

595F. SECONDARY SCHOOL COUNSELING INTERNSHIP AND SEMINAR (1–3 per semester, maximum of 6) Off-campus, supervised internships in secondary school settings with supplementary related topics, discussion, and skills training seminars. Prerequisite or concurrent: CN ED 504; available only to majors in CN ED and CNPSY.

595G. STUDENT PERSONNEL INTERNSHIP AND INTEGRATIVE SEMINAR (1–6 per semester, maximum of 9) Off-campus, supervised internships in postsecondary-related college-student personnel settings with pertinent topics, discussion; skills training seminars on campus. Prerequisite or concurrent: CN ED 551; available only to majors in CN ED and CNPSY.

596. INDIVIDUAL STUDIES (1–9)

597. SPECIAL TOPICS (1–9)

CRIME, LAW, AND JUSTICE (C L J)

BARRETT A. LEE, *In Charge; Head of the Department of Sociology*

201 Oswald Tower

814-865-0172

Degrees Conferred: Ph.D., M.A.

The Graduate Faculty

Roy L. Austin, Ph.D. (Washington) *Associate Professor of Sociology and Justice*

Thomas J. Bernard, Ph.D. (SUNY, Albany) *Professor of Criminal Justice and Sociology*

Alan A. Block, Ph.D. (UCLA) *Professor of Administration of Justice*

Alan Booth, Ph.D. (Nebraska) *Professor of Sociology and Human Development*

Chester L. Britt, Ph.D. (Arizona) *Assistant Professor of Administration of Justice and Sociology*

Frank Clemente, Ph.D. (Tennessee) *Professor of Sociology*

James Eisenstein, Ph.D. (Yale) *Professor of Political Science and Crime, Law, and Justice*

Lynne Goodstein, Ph.D. (CUNY) *Professor of Administration of Justice and Women's Studies*

John Philip Jenkins, Ph.D. (Cambridge) *Distinguished Professor of Religious Studies, History, and Criminal Justice*

John H. Kramer, Ph.D. (Iowa) *Professor of Sociology and Justice*

Barrett A. Lee, Ph.D. (Washington) *Professor of Sociology*

D. Wayne Osgood, Ph.D. (Colorado) *Professor of Crime, Law, and Justice*

R. Barry Ruback, Ph.D. (Pittsburgh) *Professor of Crime, Law, and Justice*

Darrell Steffensmeier, Ph.D. (Iowa) *Professor of Sociology and Crime, Law, and Justice*

Edward Walsh, Ph.D. (Michigan) *Associate Professor of Administration of Justice and Sociology*

Susan Welch, Ph.D. (Illinois) *Professor of Political Science and Crime, Law, and Justice*

The Department of Sociology's graduate program in Crime, Law, and Justice offers an advanced education on crime and its control to persons interested in careers in academia, public service, or private enterprise.

The M.A. and Ph.D. programs provide knowledge in crime and justice theories and research methods, on substantive issues about crime and its control including the organization and administration of the justice system, and about research and statistical methods.

Admission Requirements

Applications will be accepted through January 31 for fall admission the following year. Selection is based on transcripts, two letters of recommendation from persons familiar with the applicant's academic performance, a statement of goals, a sample of written work such as a term paper, and Graduate Record Examination (GRE) verbal and quantitative scores. The best-qualified applicants will be admitted to the master's or Ph.D. program up to the number of spaces available.

Master's Degree Requirements

Thirty credits of course work and a master's paper are required for the M.A. The course work includes a sequence of methods and statistics courses; a crime theory course; a course in the organization and administration of the justice system; and additional 500-level substantive Crime, Law, and Justice courses selected in consultation with a student's faculty committee.

A candidacy exam is required of all students seeking the Ph.D., but it can be taken only after completing a master's degree or its equivalent. This exam will consist of an evaluation by the program's graduate faculty of the student's seminar papers, master's paper or its equivalent, and overall record of performance. Students admitted with a master's degree will stand for this exam after two semesters of full-time study.

Doctoral students must also, in consultation with their committee, select 12 credits of 500-level courses outside the program that form a coherent disciplinary concentration and complement the study of Crime, Law, and Justice. A comprehensive exam must be passed by all students before intensive dissertation research begins.

The program in Crime, Law, and Justice has no formal foreign language or communication requirement. However, students are encouraged to pursue additional training in statistics, computer science, foreign language, technical writing, specialized methods, or specialized theory that will further their dissertation or career plans.

Student Aid

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AID section of the *Graduate Bulletin*, teaching assistantships support many students admitted to the program. Research assistantships also are available to qualified students through individual faculty members' grants and contracts. A number of federal agencies also offer fellowships for graduate study.

ADMINISTRATION OF JUSTICE (ADM J)

- 401. PROBATION, PAROLE, AND PARDONS (3)
- 410. CORRECTIONAL COUNSELING PROCESSES (3)
- 420. SPECIAL OFFENDER TYPES (3-6)
- 421. VIOLENT CRIME IN THE UNITED STATES (3)
- 422. VICTIMLESS CRIMES AND THE ADMINISTRATION OF JUSTICE (3)
- 423. (WMNST) RAPE AND SEXUAL VICTIMIZATION (3)
- 424. INTERNATIONAL TRAFFIC IN NARCOTICS (3)
- 425. LAW ENFORCEMENT RESPONSES TO ORGANIZED CRIME (3)
- 430. CORRECTIONAL INSTITUTIONS AND SERVICES (3)
- 440. FUNDAMENTAL TECHNIQUES OF SCIENTIFIC CRIMINAL INVESTIGATION (3)
- 441. THE JUVENILE JUSTICE SYSTEM (3)
- 445. (COM S) CRIMINAL JUSTICE AND THE COMMUNITY (3)
- 451. MINORITIES AND THE CRIMINAL JUSTICE SYSTEM (3)
- 453. (WMNST) WOMEN AND THE CRIMINAL JUSTICE SYSTEM (3)
- 460. HISTORY AND FUNCTION OF CRIMINAL JUSTICE COMPONENTS (3)
- 462. COMPARATIVE CRIMINAL JUSTICE SYSTEMS (3)
- 470. LAW OF CRIMES AND CORRECTIONS (3)
- 471. (B LAW) LEGAL RIGHTS, DUTIES, LIABILITIES OF CRIMINAL JUSTICE PERSONNEL (3)
- 472. CRIME AND THE AMERICAN COURT SYSTEM (3)
- 473. (B LAW) CRIMINAL PROCEDURE AND EVIDENCE IN THE BUSINESS COMMUNITY (3)
- 482. SEMINAR, CRIMINAL JUSTICE AGENCY ADMINISTRATION (3)
- 485. POLICING IN AMERICA (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
- 499A. EUROPEAN CRIMINAL JUSTICE (6)
- 499B. FIELD RESEARCH IN EUROPE (3)

CRIME, LAW, AND JUSTICE (C L J)

- 501. CRIMINAL JUSTICE ORGANIZATIONS AND INSTITUTIONS (3) Organizations and institutions involved in the formulation and implementation of criminal justice policy in complex social and organizational environments.

CURRICULUM AND INSTRUCTION

502. DEVELOPMENT OF CRIMINAL JUSTICE POLICY AND THE LEGAL ENVIRONMENT (3) Development of criminal justice policy during the nineteenth and twentieth centuries and the corresponding evolution of the legal environment.
503. JUSTICE POLICY AND CRIMINAL ENTERPRISE (3) The structure of criminal enterprise and policy issues relevant to controlling criminal enterprises.
509. CRIMINAL JUSTICE POLICY RESEARCH METHODS (3 per consecutive semester, maximum of 6) Application of social research methods to criminal justice policy issues, with focus on individual research projects. Prerequisites: SOC 513, 574.
510. JUSTICE POLICY AND ENVIRONMENTAL CRIME (3) Criminalization of various types of environmental pollution and resulting problems and strategies in enforcement. Prerequisite: C L J 503.
511. REGULATION OF CORPORATE AND GOVERNMENTAL CRIME (3) The developing role of criminal law in the regulation of corrupt or illegal activity in corporations and government agencies. Prerequisite: C L J 503.
512. (SOC) SEMINAR IN DEVIANT BEHAVIOR (3) Survey of theoretical and substantive issues in deviance and criminology, with emphasis on critical review of theories.
515. (SOC) RESEARCH METHODS IN CRIMINOLOGY AND DEVIANCE (3) Review of methodological issues; design and conduct of research; analysis and interpretation of findings; ethical and policy issues.
520. REFORM ISSUES IN JUSTICE POLICY (3) Reforms in criminal justice systems, with an emphasis on bureaucratic dynamics. Prerequisite: C L J 502.
530. JUVENILE JUSTICE SYSTEMS AND POLICIES (3) State and national juvenile justice systems: the sources and consequences of the present diversity. Prerequisite: C L J 501.
540. SEMINAR IN CRIMINAL JUSTICE POLICY (3) Current developments in criminal justice policy with reference to criminal enterprise, the legal environment, and administration of the justice system. Prerequisite: C L J 501, 502, or 503.
554. EVALUATING CRIMINAL JUSTICE POLICY (3) An examination of criteria and measures for evaluating criminal justice policies and the impact of various policies. Prerequisites: C L J 501, 502, 503.
585. LAW ENFORCEMENT PROCESS AND POLICE (3) An assessment of law enforcement functions, practices, and policies and their impact on crime, the community, and the justice system. Prerequisite: C L J 501.
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

CURRICULUM AND INSTRUCTION (C I)

J. DANIEL MARSHALL, *Coordinator for Graduate Programs in Curriculum and Instruction*
150 Chambers Building
814-865-2239

Degrees Conferred: Ph.D., D.Ed, M.S., M.Ed.

The Graduate Faculty

Glendon W. Blume, Ph.D. (Wisconsin) *Associate Professor of Education*
Jeanne Brady, Ph.D. (Miami) *Assistant Professor of Education*
Nancy F. Dana, Ph.D. (Florida State) *Associate Professor of Education*
Thomas M. Dana, Ph.D. (Florida State) *Associate Professor of Education*
Dorothy H. Evensen, Ph.D. (New York) *Associate Professor of Education*
Judith A. Fueyo, Ph.D. (New Hampshire) *Associate Professor of Education*
Henry A. Giroux, D.A. (Carnegie Mellon) *Professor of Education*
Daniel D. Hade, Ph.D. (Ohio State) *Associate Professor of Education*
Madlyn L. Hanes, Ph.D. (Florida) *Associate Professor of Education*
M. Kathleen Heid, Ph.D. (Maryland) *Associate Professor of Education*
Steven Herb, Ph.D. (Penn State) *Associate Librarian; Head, Education Library, Affiliate Associate Professor of Education*
Patricia H. Hinchey, Ed.D. (Columbia) *Associate Professor of Education*
Addie M. Johnson, Ed.D. (Pennsylvania) *Assistant Professor of Education*
James E. Johnson, Ph.D. (Wayne State) *Professor of Education*
Joe L. Kincheloe, Ed.D. (Tennessee) *Professor of Education*

Ravinder Koul, Ph.D. (Penn State) *Assistant Professor of Education*
 James Levin, Ph.D. (Penn State) *Affiliate Assistant Professor of Education*
 Vincent N. Lunetta, Ph.D. (Connecticut) *Professor of Education*
 J. Daniel Marshall, Ph.D. (Texas) *Associate Professor of Education*
 Kenneth R. Mechling, Ph.D. (Michigan) *Adjunct Professor of Education*
 Jamie Myers, Ph.D. (Indiana) *Associate Professor of Education*
 Murry R. Nelson, Ph.D. (Stanford) *Professor of Education*
 Robert F. Nicely, Jr., Ph.D. (Pittsburgh) *Professor of Education*
 James F. Nolan, Ph.D. (Penn State) *Associate Professor of Education*
 Frances V. Rains, Ph.D. (Indiana) *Assistant Professor of Education*
 Peter A. Rubba, Ed.D. (Indiana) *Professor of Education*
 David W. Saxe, Ph.D. (Illinois) *Associate Professor of Education*
 Ladislaus M. Semali, Ph.D. (California) *Associate Professor of Education*
 Patrick W. Shannon, Ph.D. (Minnesota) *Professor of Education*
 Martin W. Sharp, Jr., D.Ed. (Penn State) *Assistant Professor of Education*
 Martin A. Simon, Ed.D. (Massachusetts) *Associate Professor of Education*
 Kathleen A. Smith, Ph.D. (Penn State) *Adjunct Professor of Education*
 Margaret S. Smith, Ed.D. (Pittsburgh) *Assistant Professor of Education*
 Lourdes Soto, Ph.D. (Penn State) *Associate Professor of Education*
 Ron Tzur, Ph.D. (Georgia) *Assistant Professor of Education*
 Thomas D. Yawkey, Ph.D. (Illinois) *Professor of Education*
 Edward J. Zielinski, Ph.D. (Texas, Austin) *Adjunct Professor of Education*
 Carla M. Zembal-Saul, Ph.D. (Michigan) *Assistant Professor of Education*

This program provides advanced professional preparation in the special areas of curriculum and supervision, bilingual education, early childhood education, elementary education, language and literacy education, science education, social studies education, and mathematics education.

The M.S. and M.Ed. program are also available at Penn State Great Valley.

Admission Requirements

Scores from the Miller Analogies Test (MAT) or the Graduate Record Examination (GRE) are required for admission. However, applicants for the doctoral degree are strongly encouraged to take the GRE. Moreover, students with excellent academic records who wish to be considered for fellowships, scholarships, and assistantships should take the GRE as a matter of course. At the discretion of an option area, a student may be admitted provisionally for graduate study in a program without these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Students with appropriate course and professional backgrounds will be considered for admission, subject to the limitation of program facilities. For admission to the professional degree programs leading to the M.Ed. and D.Ed., teaching or equivalent experience and at least 18 credits in education are recommended.

Master's Degree Requirements

M.Ed. and M.S. candidates are expected to complete the core: EDPSY 421, C I 400, and C I 550, or the equivalent.

Candidates for the M.Ed. degree with a minor in Curriculum and Instruction must take a minimum of 6 course credits approved in advance.

Doctoral Degree Requirements

The completion of a core of competencies in curriculum, instruction, and supervision is expected of Ph.D. and D.Ed. candidates.

To meet residency requirements, the Ph.D. candidate must spend at least two consecutive semesters enrolled as a full-time student at the University Park campus. The D.Ed. candidate must spend at least two consecutive sessions (e.g., semester, summer session) enrolled as a full-time student at the University Park Campus. The communication and foreign language requirement for the Ph.D. degree may be satisfied by completing two of the following options: foreign language, statistics, computer science and technology, linguistics, demography, historiography, or qualitative research methods.

Candidates for the D.Ed. degree with a minor in Curriculum and Instruction must take a minimum of 15 course credits approved in advance by the professor in charge of graduate programs in Curriculum and Instruction.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

CURRICULUM AND INSTRUCTION (C I)

- 400. INTRODUCTION TO RESEARCH LITERATURE (3)
- 408. METHODS OF TEACHING BASIC SKILLS (4–6)
- 412W. SECONDARY TEACHING II (3)
- 494H. RESEARCH TECHNIQUES IN CURRICULUM AND INSTRUCTION (1–3)
- 495A. CLINICAL APPLICATION OF INSTRUCTION—EARLY CHILDHOOD EDUCATION (3)
- 495B. CLINICAL APPLICATION OF INSTRUCTION—ELEMENTARY AND KINDERGARTEN EDUCATION (3)
- 495C. CLINICAL APPLICATION OF INSTRUCTION—SECONDARY EDUCATION (3)
- 495D. PRACTICUM IN STUDENT TEACHING—ELEMENTARY AND KINDERGARTEN EDUCATION (12)
- 495E. PRACTICUM IN STUDENT TEACHING—SECONDARY EDUCATION (15)
- 495F. PROFESSIONAL DEVELOPMENT PRACTICUM (3)
- 496. INDEPENDENT STUDIES (1–18)
- 497, 498. SPECIAL TOPICS (1–9)
- 501. TEACHING AS INQUIRY (3) Course guides teachers to develop systematic inquiries into effective teaching and learning.
- 502. QUALITATIVE RESEARCH IN CURRICULUM AND INSTRUCTION I (3) Presentations of theoretical and practical issues related to designing and proposing qualitative research concerning curriculum, teaching and/or learning. Prerequisite: admission to a doctoral program.
- 503. QUALITATIVE RESEARCH IN CURRICULUM AND INSTRUCTION II (3) Considers forms of qualitative data, data analyses, procedures to generate data relationships, interpretation, and presentation of data. Prerequisite: C I 502.
- 504. (CI ED) PERSPECTIVES IN AFRICAN EDUCATION (3) Educational systems in selected African countries are examined with respect to colonial history, and social, political, and cultural factors.
- 550. OVERVIEW OF CONTEMPORARY SCHOOL CURRICULUM (3) Current school programs and options and their impact on pupils; problems in introducing new content into the curriculum. Prerequisites: 12 credits in education and psychology or teaching experience.
- 577. (LL ED) MULTICULTURAL ISSUES IN LITERACY EDUCATION (3) Explores research questions, and theoretical frameworks, and analyzes multicultural issues in popular media in the context of American schools. Prerequisite: LL ED 542.
- 580. (LL ED) MEDIA LITERACY, LANGUAGE, AND LITERACY IN SCHOOLS (3) Theories of media literacy, issues of non-print technology in language and literacy. Prerequisite: LL ED 480.
- 590. COLLOQUIUM (1–3)
- 595. INTERNSHIP IN CURRICULUM, SUPERVISION, OR INSTRUCTION (1–6) Internship in schools or other educational settings under supervision of graduate faculty in the student's area of specialization. Prerequisites: approval by program head; at least 15 graduate-level credits in education.
- 596. INDIVIDUAL STUDIES (1–9)
- 597. SPECIAL TOPICS (1–9)

CURRICULUM AND SUPERVISION (C & S)

- 401. MEASUREMENT AND EVALUATION OF INSTRUCTION, K–12 (3)
- 405. STRATEGIES IN CLASSROOM MANAGEMENT (3)
- 470. WORKSHOP IN SELECTED STUDIES IN CURRICULUM (1–6)
- 471. WORKSHOP IN SELECTED STUDIES IN SUPERVISION (1–6)
- 479. THE YOUNG CHILD'S PLAY AS EDUCATIVE PROCESSES (3)
- 496. INDEPENDENT STUDIES (1–18)
- 497, 498. SPECIAL TOPICS (1–9)
- 551. CURRICULUM DESIGN: THEORY AND PRACTICE (3) The analysis and use of the foundations which underlie models of curriculum design. Prerequisite: C I 550.
- 553. ISSUES AND TRENDS IN SCHOOL PROGRAMS (3 per semester, maximum of 6) In-depth study of issues and trends in designing comprehensive programs at either the elementary, middle, or high school level. Prerequisites: 12 graduate credits in education.
- 554. LONG-RANGE PLANNING FOR SCHOOL PROGRAMS (3) Strategies and techniques for conducting long-range planning of educational programs. Prerequisite: C & S 551 or C I 550.

555. DEVELOPMENT OF TEACHER EDUCATION PROGRAMS (3) Study of the components and design of teacher education programs within the constraints of institutional, professional, and legal contexts. Prerequisite: C & S 551 or C I 550.

557. SEMINAR IN CURRICULUM RESEARCH (3) Analysis of particular curriculum studies, methods and paradigms, and the general status of current research in the general curriculum field. Prerequisites: C I 400, 550.

558. STANDARD WORKS IN CURRICULUM AND INSTRUCTION (3) Study of significant empirical, historical, evaluative, philosophical, and critical works having an impact on curriculum and instruction practice. Prerequisite: C & S 551.

560. PRINCIPLES OF INSTRUCTIONAL SUPERVISION (3) Social and institutional settings for instructional supervision; functions, activities, and practices of supervision; supervisory case studies. Prerequisites: teaching or school administrative experience; 18 credits in education, at least 5 of which are methods of teaching.

563. DESIGNING STAFF DEVELOPMENT PROGRAMS (3) Designing, implementing, and evaluating effective staff development programs for personnel in educational settings. Prerequisite: C & S 560.

564. SUPERVISION THEORY (3) Critical analysis of alternative theories of instructional supervision and in-depth examination of trends and issues in supervision. Prerequisite: C & S 560.

565. METHODS OF CLASSROOM SUPERVISION AND COACHING (3) Strategies and techniques for supervision/coaching of instruction intended to enhance teacher reflection, self-direction, and autonomy. Prerequisites: C & S 560, teaching, administrative, or other professional educational work experience.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

EARLY CHILDHOOD EDUCATION (E C E)

451. INSTRUCTION IN EARLY CHILDHOOD EDUCATION DERIVED FROM DEVELOPMENTAL THEORIES (3)

452. APPROACHES TO CONTEMPORARY EARLY CHILDHOOD EDUCATION PROGRAMS (3)

453. PARENT INVOLVEMENT IN HOME, CENTER, AND CLASSROOM INSTRUCTION (2-3)

454. (HD FS) DEVELOPMENT AND ADMINISTRATION OF CHILD SERVICE PROGRAMS (3)

479. THE YOUNG CHILD'S PLAY AS EDUCATIVE PROCESSES (3)

496. INDEPENDENT STUDIES (1-18)

497, 498. SPECIAL TOPICS (1-9)

572. ISSUES AND TRENDS IN EARLY CHILDHOOD EDUCATION (3 per semester, maximum of 9) Research, experimental programs, and emerging trends in early childhood education; relationships between educational experiences and later intellectual and emotional development. Prerequisites: E C E 452, EDPSY 400.

580. YOUNG MULTILINGUAL/MULTICULTURAL LEARNERS (3) Multilingual/multicultural dimensions of young learners; language, cultural-ethnic social milieu and family, school, community, religious impacts, and acculturation philosophies. Prerequisite: E C E 452, 479, or 453.

588. EDUCATIONAL ROLE OF THE FAMILY (3) Parent-child-teacher relationships, cognitive socialization, and academic attainments; proximal/distal variables: family structure, history, processes, content, community, culture. Prerequisites: E C E 453, HD FS 418, or SOC 315.

589. PLAY AND EARLY CHILDHOOD EDUCATION (3) Developmental significance of play, processes, and development; role of the adult in child's play; educational practices. Prerequisites: HD FS 429 or PSY 425.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

LANGUAGE AND LITERACY EDUCATION (LL ED)

400. TEACHING READING IN THE ELEMENTARY SCHOOL (3)

401. TEACHING LANGUAGE ARTS IN ELEMENTARY SCHOOL (3)

402. TEACHING CHILDREN'S LITERATURE (3)

411. TEACHING LANGUAGE ARTS IN SECONDARY SCHOOLS I (3)

412. TEACHING LANGUAGE ARTS IN SECONDARY SCHOOLS II (3)

420. ADOLESCENT LITERATURE AND LITERACY (3)

424. SEMINAR IN FOREIGN LANGUAGE AND BILINGUAL EDUCATION (3)

425. METHODS OF TEACHING IN BILINGUAL EDUCATION (3)

445. TEACHING ENGLISH IN BILINGUAL/DIALECTAL EDUCATION (3)
446. REMEDIAL READING IN THE CLASSROOM (3)
450. CONTENT AREA READING (3)
467. CHILDREN'S LITERATURE IN THE CLASSROOM (3)
480. MEDIA LITERACY IN THE CLASSROOM (3)
495. SCHOOL PRACTICUM IN READING (1-18)
496. INDEPENDENT STUDIES (1-18)
- 497, 498. SPECIAL TOPICS (1-9)
500. THE READING AND WRITING CLASSROOM (3) Analysis of reading and writing processes and the development of integrated language arts programs for elementary schools. Prerequisite: LL ED 400.
501. TEACHING WRITING IN ELEMENTARY AND SECONDARY SCHOOLS (3) In-depth examination of writing development and the development of writing component of language arts programs K-12. Prerequisites: LL ED 500, 504, or 512.
502. STUDIES IN LITERATURE FOR CHILDREN (3) Study of various genres of children's literature from various critical perspectives. Emphasis on role of literature in children's lives. Prerequisite: LL ED 402.
503. (ENGL) RESEARCH METHODS IN COMPOSITION (3) Introduction to the issues and methods of empirical research in composition.
512. TEACHING LANGUAGE, LITERACY, AND LITERATURE IN SECONDARY SCHOOLS (3) Collaborative inquiry into the curricular design and experience of language, literacy, media, and literature in adolescents' personal and social lives. Prerequisite: LL ED 412.
520. LITERATURE FOR ADOLESCENTS (3) Critical study of adolescent literature, its diversity of cultural voices, and designs for its use in secondary school classrooms. Prerequisite: LL ED 420.
526. (EDPSY) THE PSYCHOLOGY OF READING (3) Psychological principles underlying the process of reading and comprehending, with application to instruction. Prerequisite: EDPSY 421.
541. ADOLESCENT AND CHILDREN'S LITERATURE RELATED TO ETHNIC AND SOCIAL ISSUES (3) Literature, K-12; study of literary symbolism, ethnic literature, issues, e.g., sex, death, adoption, divorce in trade books. Prerequisite: LL ED 402.
542. (CI ED) ISSUES IN LITERACY EDUCATION (3) Discussion of philosophical, sociological, historical, and curricular issues in literacy education. Prerequisite: LL ED 500 or 512.
544. CROSS-CULTURAL RESEARCH IN BILINGUAL EDUCATION (3) Analysis of cross-cultural research methodology in bilingual education. Prerequisites: 12 credits in education and/or psychology; 3 credits in statistics.
545. LITERACY AND LANGUAGE ASSESSMENT FOR INSTRUCTIONAL DECISIONS (3) Diagnosis of reading difficulties; genesis of reading problems; achievement, diagnostic, and capacity tests; application in simulation activities. Prerequisite: EDPSY 450, LL ED 500.
550. THEORY AND PRACTICUM IN ASSESSMENT AND REMEDIATION OF READING DIFFICULTIES (3) Links theory and practice in supervised practicum involving design and analysis of appropriate assessment and instructional procedures for elementary and secondary students. Prerequisites: LL ED 500, 545.
560. (ADTED) TEACHING READING TO COLLEGE STUDENTS AND ADULTS (3) Reading literacy for adults, including college reading, Adult Basic Education (ABE), and General Educational Development (GED) programs. Prerequisite: LL ED 500 or teaching experience.
565. ANALYSIS OF THEORY AND PRACTICE IN BILINGUAL EDUCATION PROGRAM (3) Classroom analysis, observation, and research of instructional procedures, materials, and evaluation strategies used in bilingual education. Prerequisites: LL ED 424; 12 credits in education and psychology.
566. BILINGUAL EDUCATION AND THE HISPANIC CHILD (3) Analysis of the research and literature related to teaching bilingual Hispanic students; examines problems, issues, and strategies. Prerequisites: 12 credits in education and/or psychology.
577. (CI) MULTICULTURAL ISSUES IN LITERACY EDUCATION (3) Explores research questions, and theoretical frameworks, and analyzes multicultural issues in popular media in the context of American schools. Prerequisite: LL ED 542.
580. (CI) MEDIA LITERACY, LANGUAGE, AND LITERACY IN SCHOOLS (3) Theories of media literacy, issues of non-print technology in language and literacy. Prerequisite: LL ED 480.
590. COLLOQUIUM (1-3)
594. RESEARCH IN LANGUAGE AND LITERACY EDUCATION (3) Cooperative design and study of research in language and literacy education. Prerequisite: CI 400 or EDPSY 400.
- 595A. DIAGNOSIS AND REMEDIAL PROCEDURES (3-6) Advanced practicum; diagnostic testing and remedial instruction of more severe types of reading disability; supervisory experiences, if appropriate. Prerequisite: LL ED 545.

595B. PRACTICUM IN BILINGUAL EDUCATION (1–6) Advanced internship in curriculum, supervision, and instruction in bilingual education setting. Prerequisites: 12 credits in education and/or psychology; 12 credits in bilingual education.

596. INDIVIDUAL STUDIES (1–9)

597. SPECIAL TOPICS (1–9)

MATHEMATICS EDUCATION (MTHED)

411. TEACHING SECONDARY MATHEMATICS I (3)

412. TEACHING SECONDARY MATHEMATICS II (3)

420. TEACHING MATHEMATICS IN THE ELEMENTARY SCHOOLS (3)

424. CONTEMPORARY SCHOOL MATHEMATICS PROGRAMS (3)

427. TEACHING MATHEMATICS IN TECHNOLOGY-INTENSIVE ENVIRONMENTS (3) (3)

430. STUDENTS' MATHEMATICAL THINKING (3)

496. INDEPENDENT STUDIES (1–18)

497, 498. SPECIAL TOPICS (1–9)

520. ANALYSIS OF RESEARCH IN MATHEMATICS EDUCATION (3) Survey of the status of knowledge about mathematics learning and instruction, K–12; analysis of research procedures; instruments for evaluating research. Prerequisites: MTHED 420 or 412; 3 credits in statistics; teaching experience.

523. PROJECTS IN MATHEMATICS EDUCATION RESEARCH, CURRICULUM DEVELOPMENT, AND EVALUATION (1–3 per semester, maximum of 24) Conceptualizing, designing, conducting, and reporting mathematics education research, curriculum development, and/or evaluation projects. Prerequisites: Enrollment in C I graduate program and by permission of the Mathematics Education emphasis area; course in psychological foundations and course in qualitative or quantitative research foundation.

525. RESEARCH PARTICIPATION IN SCHOOL MATHEMATICS CURRICULUM CONSTRUCTION (3) Development of theoretical bases for the construction of instructional materials in mathematics; research participation in preparing and testing curriculum materials.

527. RESEARCH IN THE USE OF TECHNOLOGY IN MATHEMATICS EDUCATION (3) Reviewing, critiquing, designing, and conducting research on mathematics learning and teaching in technology intensive environments. Prerequisite: MTHED 427.

530. MATHEMATICAL THINKING AT THE SECONDARY AND EARLY COLLEGE LEVELS (3) Exploring and applying theories of advanced mathematical thinking; reviewing, conducting research on mathematical thinking at secondary and early college levels. Prerequisites: enrollment in C I doctoral program with Mathematics Education emphasis; mathematics background equivalent to a bachelor's degree in mathematics.

590. COLLOQUIUM (1–3)

595. ADVANCED CLINICAL INTERNSHIP IN MATHEMATICS LEARNING (3) Supervised internship in advanced procedures for the implementation of diagnostic/prescriptive approaches as a strategy for improving mathematics learning. Prerequisite: 6 credits in mathematics education.

596. INDIVIDUAL STUDIES (1–9)

597. SPECIAL TOPICS (1–9)

SCIENCE EDUCATION (SCIED)

411. TEACHING SECONDARY SCIENCE I (3)

412. TEACHING SECONDARY SCIENCE II (3)

454. SCIENCE IN EARLY CHILDHOOD EDUCATION (3)

455. FIELD NATURAL HISTORY FOR TEACHERS (3)

456. TEACHING OF CONSERVATION OF NATURAL RESOURCES IN THE SCHOOLS (3)

457. TEACHING CONSERVATION AND ENVIRONMENTAL ISSUES IN THE SCHOOLS (3)

458. TEACHING SCIENCE IN THE ELEMENTARY SCHOOL (3)

470. SELECTED STUDIES IN SCIENCE EDUCATION (1–6)

496. INDEPENDENT STUDIES (1–18)

497, 498. SPECIAL TOPICS (1–9)

556. THE SUPERVISION OF SCIENCE CURRICULUM (3) Supervision of elementary and secondary science teachers as they develop K–12 programs in the public schools. Prerequisites: 6 credits in science methods, 20 credits in science or equivalent, and teaching experience.

558. RESEARCH PROBLEMS IN SCIENCE TEACHING (3) Problems in research dealing with curriculum, materials, evaluation, and supervision of science teaching and learning. Prerequisites: SCIED 412 or 458; teaching experience.

DEMOGRAPHY

559. ANALYSIS OF INSTRUCTION IN ELEMENTARY SCIENCE EDUCATION (3) Analysis of the history, issues, trends, and research in elementary science education. Prerequisites: teaching experience, 3 credits in elementary science methods, and 18 credits of science courses.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

SOCIAL STUDIES EDUCATION (SS ED)

411. TEACHING SECONDARY SOCIAL STUDIES I (3)

412. TEACHING SECONDARY SOCIAL STUDIES II (3)

430W. TEACHING SOCIAL STUDIES IN THE ELEMENTARY GRADES (3)

470. ISSUES IN SOCIAL STUDIES EDUCATION (1-6)

496. INDEPENDENT STUDIES (1-18)

497, 498. SPECIAL TOPICS (1-9)

530. INSTRUCTIONAL PRACTICES IN THE SOCIAL STUDIES (3) Social studies innovations in the classroom, new programs, new materials, new methods, and evaluation. Prerequisite: one year of teaching experience.

532. CURRICULUM MODELS IN SOCIAL STUDIES EDUCATION (3) Study of past and proposed curricula in elementary and secondary social studies. Various means of judging curricula will be offered. Prerequisite: C I 495D.

533. RESEARCH IN THE TEACHING OF SOCIAL STUDIES (3) Procedures and methods of research for the teaching of social studies, strategies of investigation, and review of research literature. Prerequisites: 12 credits in the social sciences on the 400 or 500 level and teaching experience.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

DEMOGRAPHY (DEMOG)

GORDON F. DE JONG, *In Charge*

601 Oswald Tower

814-865-0486

Degrees Conferred: Students electing this option through participating programs will earn a degree with a dual title at both the Ph.D. and M.A. levels, i.e., Ph.D. in (graduate program name) and Demography, or M.A. or M.S. in (graduate program name) and Demography.

The Graduate Faculty

David G. Abler, Ph.D. (Chicago) *Associate Professor of Agricultural Economics*

Alan Booth, Ph.D. (Nebraska) *Professor of Sociology*

Linda M. Burton, Ph.D. (USC) *Professor of Human Development and Sociology*

Karen Carver, Ph.D. (Maryland) *Assistant Professor of Sociology*

Gretchen T. Cornwell, Ph.D. (Penn State) *Assistant Professor of Rural Sociology*

Gordon F. De Jong, Ph.D. (Kentucky) *Distinguished Professor of Sociology*

David J. Eggebeen, Ph.D. (North Carolina) *Associate Professor of Human Development*

Jill L. Findeis, Ph.D. (Washington State) *Associate Professor of Agricultural Economics*

Glenn Firebaugh Ph.D. (Indiana) *Professor of Sociology*

Mark S. Handcock, Ph.D. (Chicago) *Associate Professor of Statistics*

Mark D. Hayward, Ph.D. (Indiana) *Professor of Sociology*

Craig R. Humphrey, Ph.D. (Brown) *Associate Professor of Sociology and American Studies*

Rukmalie Jayakody, Ph.D. (Michigan) *Assistant Professor of Human Development and Family Studies*

Leif I. Jensen, Ph.D. (Wisconsin) *Associate Professor of Rural Sociology*

Patricia L. Johnson, Ph.D. (Michigan) *Associate Professor of Anthropology and Women's Studies*

Valarie King, Ph.D. (Pennsylvania) *Assistant Professor of Sociology, and Human Development and Family Studies*

Nancy S. Landale, Ph.D. (Washington) *Professor of Sociology*

Barrett A. Lee, Ph.D. (Washington) *Professor of Sociology*

Daniel T. Lichter, Ph.D. (Wisconsin) *Professor of Sociology*

Bruce G. Lindsay, Ph.D. (Washington) *Distinguished Professor of Statistics*

Stephen A. Matthews, Ph.D. (Wales College of Cardiff) *Assistant Professor of Geography*
 Diane K. McLaughlin, Ph.D. (Penn State) *Assistant Professor of Rural Sociology*
 Martina Morris, Ph.D. (Chicago) *Professor of Sociology and Statistics*
 Salvador R. Oropesa, Ph.D. (Washington) *Associate Professor of Sociology*
 Suet-ling Pong, Ph.D. (Chicago) *Associate Professor of Foundations and Comparative/International Education*
 Michael Rendall, Ph.D. (Brown) *Associate Professor of Sociology*
 Warren C. Robinson, Ph.D. (Princeton) *Professor Emeritus of Economics*
 Wayne A. Schutjer, Ph.D. (Michigan State) *Professor of Agricultural Economics*
 David Shapiro, Ph.D. (Princeton) *Professor of Economics and Women's Studies*
 Graham B. Spanier, Ph.D. (Northwestern) *Professor of Human Development and Sociology*
 C. Shannon Stokes, Ph.D. (Kentucky) *Professor of Rural Sociology*
 Kenneth Weiss, Ph.D. (Michigan) *Distinguished Professor of Anthropology and Genetics*
 James W. Wood, Ph.D. (Michigan) *Professor of Anthropology*
 Wilbur Zelinsky, Ph.D. (California, Berkeley) *Professor Emeritus of Geography*

The Demography dual-title degree program option is administered by the Demography Program Committee, which is responsible for management of the program. The committee maintains program definition, identifies faculty and courses appropriate to the option, and recommends policies and procedures for its operation to the dean of the Graduate School. This dual-title degree program is offered as an option to graduate major programs in three colleges: Agricultural Sciences, Health and Human Development, and the Liberal Arts. The option enables students from diverse graduate programs to attain and be identified with the content, techniques, methodology, and policy implications of demography, while maintaining a close association with areas of application. Through demography, students study (1) the size, composition, and distribution of the population; (2) changes in these characteristics; (3) the processes that determine these changes—fertility, migration, and mortality; and (4) their social, economic, and cultural causes and consequences. To pursue a dual-title degree under this program option, the student must apply to the Graduate School and register through one of the following graduate programs: Agricultural Economics, Anthropology, Economics, Human Development and Family Studies, Rural Sociology, or Sociology.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

There are no prerequisites for admission to the M.A., M.S., or Ph.D. program options other than those imposed by the participating graduate program.

All application materials should be submitted by February 1. Applicants should have a junior/senior cumulative average of at least 3.00 (on a 4.00 scale) and appropriate courses in statistics and in the social science department to which they are applying. The application should include three letters of reference and a statement describing and explaining the applicant's interest in demography and goals during and after graduate study. TOEFL scores are required of all students for whom English is a second language.

Degree Requirements

To qualify for a dual-title degree, students must satisfy the requirements of the graduate program in which they are enrolled, including the communication/foreign language requirements, if any. In addition, they must satisfy the minimum requirements in the Demography option described here, as established by the Demography Program Committee. Within this framework, final course selection is determined by students and their degree committees. All dual-title degree candidates who are in residence must enroll in DEMOG 590 for 1 credit each year.

Master's Degree: For the M.A. and M.S. degree with the Demography option, 12 course credits are required in addition to the colloquium credit or credits. A minimum of 3 credits is required in each of the following areas: (1) disciplinary perspective courses—ANTH 473, 475, ECON 463, SOC 423; (2) demographic methods courses—ANTH 408, GEOG 557, SOC 473, 576, 577; (3) seminars in demographic processes—SOC 521, 523, 535, R SOC 525, DEMOG 597, SOC 597; (4) seminars in population studies—ECON 516, SOC 522, 531, 554, R SOC 530, HDFS 531, 545, AG ECON 550, 597, EDTHP 516, DEMOG 597.

Particular courses may satisfy both the graduate major program requirements and those of the Demography option. The thesis supervisor must be a member of the graduate faculty recommended by the chair or the graduate officer of the program granting the degree and approved by the Demography Program

Committee as qualified to supervise thesis work in demography. If a no-thesis option is available in the student's graduate program, a paper or report may be written in lieu of the M.A. or M.S. thesis. A student selecting the paper instead of a thesis must take an additional 3 credits in the Demography option.

Ph.D. Degree: For the Ph.D. degree with the Demography option, a minimum of 24 credits (a minimum of 27 credits for students who completed a nonthesis M.A. or M.S. program) is required in addition to the colloquium credits. For students entering with a master's degree from another institution, equivalent course credits may be accepted. The following minimum number of credits is required in each curriculum category: 3 credits of disciplinary perspective courses; 6 credits of demographic methods courses; 6 credits of seminars in demographic processes; 3 credits of seminars in population studies; and 6 credits of electives. Final course selection is determined in consultation with the doctoral committee.

The doctoral committee is recommended by the graduate major program granting the degree. A five-member committee is required for a dual-title degree program. The chair and at least one additional member of the doctoral committee must be members of the graduate faculty approved by the Demography Program Committee as qualified to supervise doctoral theses in demography. The Demography faculty members on the student's committee are responsible for administering an examination in demography that constitutes a portion of the comprehensive examination of the doctoral student in the program option. A dissertation on a demographic topic is required of students in the dual-title degree program.

Other Relevant Information

A Ph.D. minor in Demography is available for doctoral students in graduate programs other than the dual-title participating programs who find it advantageous to include demographic content, methods, and policy analysis in their program of study. The student's doctoral committee must approve the choice of this minor, and one member of the doctoral committee must be from the Demography faculty.

To qualify for a minor in Demography, students must satisfy the requirements of their graduate major program and take at least 15 credits in demography in addition to colloquium credits. A minimum of at least 3 credits each in (1) disciplinary perspective, (2) demographic methods courses, (3) seminars in demographic processes, and (4) seminars in population studies is required. Students must enroll in DEMOG 590 for 1 credit during each year enrolled in the program and in residence.

Student Aid

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AID section of the *Graduate Bulletin*, the following award typically has been available to graduate students in this program:

HEWLETT FOUNDATION AND FORD FOUNDATION AWARDS—Available to demography students from developing countries.

DEMOGRAPHY (DEMOG)

590. COLLOQUIUM (1–3) Professional development seminars which consist of a series of individual lectures and workshops by faculty, students, or outside speakers.

596. INDIVIDUAL STUDIES (1–9)

597. SPECIAL TOPICS (1–9)

EARTH SCIENCES (EARTH)

LEE R. KUMP, *Associate Head for Graduate Programs and Research*
303 Deike Building
814-863-1274

Degrees Conferred: D.Ed., M.Ed

The Graduate Faculty

John J. Cahir, Ph.D. (Penn State) *Professor of Meteorology*
John H. E. Clark, Ph.D. (Florida State) *Associate Professor of Meteorology*
Roger J. Cuffey, Ph.D. (Indiana) *Professor of Paleontology*
John A. Dutton, Ph.D. (Wisconsin) *Professor of Meteorology*
Peirce F. Lewis, Ph.D. (Michigan) *Professor of Geography*
Dennis W. Thomson, Ph.D. (Wisconsin) *Professor of Meteorology*
Brent M. Yarnal, Ph.D. (Simon Fraser) *Assistant Professor of Geography*

The M.Ed. program is designed to meet the needs of science teachers in elementary and secondary schools.

The D.Ed. program is designed for secondary school and college science teachers. The earth science fields of study are geography, geological sciences (geology, geochemistry and mineralogy, or geophysics), and meteorology.

Admission Requirements

Scores from the Graduate Record Examination (GRE) Aptitude Test (verbal and quantitative) are required for completion of the admission process. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Students with a 2.50 junior/senior average (on a 4.00 scale), 18 credits in education and related psychology, and 6 credits in earth science fields or other appropriate background will be considered for admission to the M.Ed. program. The M.Ed. program is not offered during the summer session.

In order to enter the D.Ed. program a candidate should present evidence of competence at the baccalaureate level in one of the earth sciences (geography, geological sciences, or meteorology) or in an allied science curriculum. Students with a 3.00 junior/senior average and with appropriate course backgrounds will be considered for admission. Exceptions to the minimum 3.00 grade-point average will be made for students with special backgrounds, abilities, and interests.

Master's Degree Requirements

The M.Ed. candidate selects one of the earth sciences as an area of concentration, takes at least 12 credits in it, and is required to write a paper in that area. An additional 12 credits must be taken in the other two fields of earth sciences; or 6 credits may be taken in one of the earth science fields plus 6 credits in other science or engineering fields. Two education courses, C I 400 and SCIED 558, are required as a minor.

Doctoral Degree Requirements

The course requirements are planned by the candidate's committee. A minimum of 60 credits must include one area of concentration within the earth sciences—geography, geological sciences (geology, geochemistry and mineralogy, or geophysics), or meteorology—plus courses from each of the other two earth science areas. A minimum of 15 credits each is required in professional education and in thesis research. The thesis topic must be in one of the earth sciences. Three consecutive semesters of residence are required for the D.Ed. degree. The student's D.Ed. committee shall normally consist of five members—two members from the area of concentration, one member from each of the other two earth science fields, and one member from education.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

EARTH SCIENCES

400. EARTH SCIENCES SEMINAR (3)

402. EVOLUTION OF THE ATMOSPHERE AND OCEANS (3)

496. INDEPENDENT STUDIES (1–18)

497. SPECIAL TOPICS (1–9)

500. EARTH SCIENCES RESEARCH (1–6) Relationships among the earth sciences revealed by theory, analytical methods, or a selected problem.

597. SPECIAL TOPICS (1–9)

ECOLOGY (ECLGY)

RICHARD H. YAHNER, *Chair, Intercollege Graduate Degree Program in Ecology*
107 Ferguson Building
814-863-3201; rhy@psu.edu

Degrees Conferred: Ph.D., M.S.

The Graduate Faculty

- §Marc D. Abrams, Ph.D. (Michigan State) *Professor of Forest Ecology and Physiology*
 §Dean E. Arnold, Ph.D. (Cornell) *Adjunct Assistant Professor of Aquatic Ecology*
 §Stephen J. Beckerman, Ph.D. (New Mexico) *Associate Professor of Anthropology*
 #Jean-Marc Bollag, Ph.D. (Basel) *Professor of Soil Microbiology*
 §Todd W. Bowersox, Ph.D. (Penn State) *Professor of Silviculture*
 §Margaret C. Brittingham, Ph.D. (Wisconsin) *Associate Professor of Wildlife Resources*
 §Robert P. Brooks, Ph.D. (Massachusetts) *Professor of Wildlife Ecology and Wetlands*
 §E. Alan Cameron, Ph.D. (California, Berkeley) *Professor of Entomology*
 §Robert F. Carline, Ph.D. (Wisconsin) *Adjunct Professor of Fish and Wildlife Science*
 §Jonathon D. Chorover, Ph.D. (Berkeley) *Assistant Professor of Environmental Soil Chemistry*
 *Andrew G. Clark, Ph.D. (Stanford) *Associate Professor of Biology*
 C. Andrew Cole, Ph.D. (Southern Illinois) *Affiliate Assistant Professor of Landscape Architecture*
 Roger J. Cuffey, Ph.D. (Indiana) *Professor of Geosciences*
 Donald D. Davis, Ph.D. (Penn State) *Professor of Plant Pathology*
 David R. DeWalle, Ph.D. (Colorado State) *Professor of Forest Hydrology*
 David M. Eissenstat, Ph.D. (Utah State) *Associate Professor of Wood Plant Physiology*
 Steven L. Fales, Ph.D. (Purdue) *Professor of Crop Management*
 C. Paola Ferreri, Ph.D. (Michigan State) *Assistant Professor of Fisheries Management*
 Charles R. Fisher, Jr., Ph.D. (California, Santa Barbara) *Associate Professor of Biology*
 Shelby J. Fleisher, Ph.D. (Auburn) *Associate Professor of Entomology*
 Hector E. Flores, Ph.D. (Yale) *Professor of Plant Pathology and Biotechnology*
 §Michael R. Gannon, Ph.D. (Texas Tech) *Assistant Professor of Biology*
 §Lauraine K. Hawkins, Ph.D. (New Mexico) *Assistant Professor of Biology*
 §S. Blair Hedges, Ph.D. (Maryland) *Assistant Professor of Biology*
 Arthur A. Hower, Jr., Ph.D. (Penn State) *Professor of Entomology*
 Heather D. Karsten, Ph.D. (Cornell) *Assistant Professor of Crop Production/Ecology*
 *§K. C. Kim, Ph.D. (Minnesota) *Professor of Entomology*
 Roger Koide, Ph.D. (California, Berkeley) *Associate Professor of Horticulture Ecology*
 Jeffrey A. Kurland, Ph.D. (Harvard) *Associate Professor of Anthropology and Human Development*
 Les E. Lanyon, Ph.D. (Ohio State) *Associate Professor of Soil Fertility*
 *Bruce G. Lindsay, Ph.D. (Washington) *Distinguished Professor of Statistics*
 Jonathan P. Lynch, Ph.D. (California, Davis) *Assistant Professor of Plant Nutrition*
 James H. Marden, Ph.D. (Vermont) *Assistant Professor of Aquatic Ecology*
 §Thomas H. Martin, Ph.D. (North Carolina State) *Assistant Professor of Aquatic Ecology*
 §Larry H. McCormick, Ph.D. (Penn State) *Professor of Forest Resources*
 *Archie J. McDonnell, Ph.D. (Penn State) *Professor of Civil Engineering*
 §*Wayne L. Myers, Ph.D. (Michigan) *Associate Professor of Forest Biometrics*
 *Ganapati P. Patil, Ph.D. (Michigan) *Distinguished Professor of Mathematical Statistics*
 Gary W. Petersen, Ph.D. (Wisconsin) *Professor of Soil Genesis and Morphology*
 Michael C. Saunders, Ph.D. (Georgia) *Associate Professor of Entomology*
 §John C. Schultz, Ph.D. (Washington) *Professor of Entomology*
 William E. Sharpe, Ph.D. (West Virginia) *Professor of Forest Hydrology*
 §John M. Skelly, Ph.D. (Penn State) *Professor of Plant Pathology*
 Zane Smilowitz, Ph.D. (Cornell) *Professor of Entomology*
 §Jay R. Stauffer, Jr., Ph.D. (Virginia Tech) *Professor of Ichthyology*
 §Kim C. Steiner, Ph.D. (Michigan State) *Professor of Forest Biology*
 §Andrew G. Stephenson, Ph.D. (Michigan) *Professor of Biology*
 Kenneth R. Tamminga, M.Pl. (Queens, Canada) *Assistant Professor of Landscape Architecture*
 §Alan H. Taylor, Ph.D. (Colorado) *Associate Professor of Geography*
 §Christopher F. Uhl, Ph.D. (Michigan) *Associate Professor of Biology*
 #Richard F. Unz, Ph.D. (Rutgers) *Professor of Environmental Microbiology*
 Lisa K. Valburg, Ph.D. (Washington State) *Assistant Professor of Biology*
 Thomas L. Watschke, Ph.D. (Iowa State) *Professor of Turfgrass Science*
 Thomas S. Whittam, Ph.D. (Arizona) *Associate Professor of Biology*
 §Carl B. Wolfe, Jr., Ph.D. (Tennessee) *Professor of Biology*
 §Richard H. Yahner, Ph.D. (Ohio) *Professor of Wildlife Conservation*

Note: Quantitative option faculty are designated by (*), microbial option faculty by (#), and conservation biology option faculty by (§). See text for further explanation.

This intercollege program emphasizes the properties of ecosystems by focusing attention on interactions of single organisms, populations, and communities with their environment. It is designed to give students a basic understanding of ecological theory and hypothesis testing and is complementary to other environmental programs that emphasize the human role in ecosystems.

The program is administered by a committee drawn from faculty members in several departments and colleges of the University. This committee and its chair are appointed by the dean of the Graduate School. The instructional staff is composed of participating faculty in those departments offering graduate courses in fields closely allied to ecology.

The committee appointed by the Graduate School for each candidate in Ecology is selected from faculty in the student's area of specialization. The committee has the responsibility for determining the course program and research acceptable in satisfying degree requirements.

Quantitative, Microbial, and Conservation Biology Options: Three options for specialization are offered: Quantitative Ecology, Microbial Ecology, and Conservation Biology. The quantitative option includes mathematical and statistical modeling and applications of statistics to experimental design and data analysis. The microbial option includes basic aquatic and soil microbial ecology and applications to recycling of materials and release of genetically engineered organisms. The conservation biology option is concerned with problems of maintaining the rapidly disappearing diversity of organisms and their habitats, and the global reservoir of genetic diversity that these organisms represent. Each option entails extra course requirements plus a thesis directed by an ecology faculty member in the option. Quantitative option faculty are designated by (*), microbial option faculty by (#), and conservation biology option faculty by (§). Additional information can be obtained from the option coordinators: Andrew G. Clark, quantitative; Jean-Marc Bollag, microbial; or J. R. Stauffer, Jr., conservation biology.

Admission Requirements

Scores from the Graduate Record Examination (GRE), including verbal, quantitative, and advanced biology test, are required for admission. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Students meeting the admission requirements of the Graduate School will be considered up to the number of spaces available in selecting candidates in this program. Candidates should have a strong science background, including chemistry through organic chemistry, mathematics through calculus, physics, and biology. A limited number of such courses can be made up while the student is pursuing graduate study. Students with a background in another discipline that has potential value to original ecological work will be seriously considered. A junior/senior grade-point average of 3.00 or better (on a 4.00 scale) is required.

Students are strongly urged to choose their research interests and initiate communication with the relevant faculty member(s) before applying for admission. A student will not be admitted without the commitment of a faculty member to serve as the student's research adviser. Teaching and research assistantships are available only through the student's faculty adviser.

The top sheet of the graduate application and application fees must be sent to Graduate Enrollment Services, 114 Kern Building. The other copies of the graduate application, transcripts, three letters of recommendation, test scores from the GRE General Test and the Subject Test in biology, and a one-page statement regarding academic and professional goals must be sent to the Graduate Program in Ecology office. A student must obtain the commitment of a faculty member to be the student's research adviser before admission will be granted; thus, applicants are urged to initiate communication with the appropriate faculty members as early as possible. The adviser may be able to help the student obtain financial aid. Although applications will be accepted throughout the year, applicants are encouraged to submit materials prior to February 1.

Degree Requirements

The instructional program includes three graduate core courses in ecology, an advanced statistics course (two courses for Ph.D.), augmented by an additional integrated group of seminars and courses selected for each student by the committee, and a research project directed by the thesis adviser. The nonthesis option is available for the M.S. degree, at the adviser's discretion.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by strong performance in two semesters of one foreign language or the equivalent.

Other Relevant Information

Detailed descriptions of courses now available for students majoring in Ecology may be found under the offerings of several ecologically oriented departments.

Student Aid

Graduate Assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

ECOLOGY (ECLGY)

590. (BIOL) COLLOQUIUM (1-3)

ECONOMICS (ECON)

ROBERT C. MARSHALL, *Head of the Department*

613 Kern Building

814-865-1456

Degrees Conferred: Ph.D., M.A.

The Graduate Faculty

Herman J. Bierens, Ph.D. (Amsterdam) *Professor of Economics*

Eric W. Bond, Ph.D. (Rochester) *Professor of Economics*

N. Edward Coulson, Ph.D. (California, San Diego) *Associate Professor of Economics*

Irwin Feller, Ph.D. (Minnesota) *Professor of Economics*

Thomas G. Fox, Ph.D. (Syracuse) *Professor of Economics*

Eric Ghysels, Ph.D. (Minnesota) *Professor of Economics*

Thomas Gresik, Ph.D. (Northwestern) *Associate Professor of Economics*

Barry Ickes, Ph.D. (California, Berkeley) *Associate Professor of Economics*

Susumi Imai, Ph.D. (Minnesota) *Assistant Professor of Economics*

Philip A. Klein, Ph.D. (California, Berkeley) *Professor of Economics*

Kala Krishna, Ph.D. (Princeton) *Professor of Economics*

Vijay Krishna, Ph.D. (Princeton) *Professor of Economics*

Derek Laing, Ph.D. (Essex) *Associate Professor of Economics*

Victor Li, Ph.D. (Northwestern) *Assistant Professor of Economics*

Raymond E. Lombra, Ph.D. (Penn State) *Professor of Economics*

Robert C. Marshall, Ph.D. (California, San Diego) *Professor of Economics*

Jon P. Nelson, Ph.D. (Wisconsin) *Professor of Economics*

Bee-Yan Roberts, Ph.D. (Wisconsin) *Associate Professor of Economics*

Mark J. Roberts, Ph.D. (Wisconsin) *Professor of Economics*

James D. Rodgers, Ph.D. (Virginia) *Professor of Economics*

David Shapiro, Ph.D. (Princeton) *Professor of Economics*

Norman Swanson, Ph.D. (California, San Diego) *Assistant Professor of Economics*

Joseph V. Terza, Ph.D. (Pittsburgh) *Associate Professor of Economics*

Neil Wallace, Ph.D. (Chicago) *Professor of Economics*

Ping Wang, Ph.D. (Rochester) *Associate Professor of Economics*

Opportunities are available for study in: economic theory, econometrics, economic development and transition, income distribution, industrial organization, international economics, labor economics, mathematical economics, monetary theory and policy, public finance, and urban economics. In addition to the courses offered in the above areas, formal graduate course work is available in economic demography, environmental economics, economics of technological change, economic doctrines, and economic development and transition of developed areas.

Students also may qualify for admission to the Demography option, consisting of interdisciplinary course work, with special emphasis on the economic, social, and geographic issues arising from the dynamics of population change.

Admission Requirements

Scores from the Graduate Record Examination (GRE) general tests are required for admission. Whenever possible, scores on the GRE advanced economics test should also be provided. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Students entering the master's program should have at least 12 credits in economics, 3 credits in statistics, and 6 credits in calculus. Students entering the doctoral program should have successfully completed at least 12 credits in economics, 3 credits in statistics, and 9 credits in calculus and higher-level mathematics.

Course work in linear algebra is strongly recommended. Students entering the doctoral program need not have a master's degree. Students are permitted to enter the master's and doctoral programs with deficiencies but must pass courses to eliminate deficiencies as soon as possible.

Students with a 3.00 junior/senior grade-point average or a 3.00 average in previous graduate courses (on a 4.00 scale), a 3.00 average in economics courses, and appropriate course backgrounds will be considered for study. Exceptions to the minimum grade-point averages may be made for students with special backgrounds, abilities, and interests. The best-qualified applicants will be accepted up to the number of spaces that are available for new students.

Degree Requirements

Requirements for the M.A. degree are satisfactory completion of ECON 500, 501, 502, and 503, plus 18 additional credits including at least 6 credits in a major field of specialization in economics. A maximum of 6 credits can be elected in course work outside economics. The nonthesis option is available for the M.A. degree.

For the Ph.D. degree, all students are required to take a written candidacy examination in economic theory during their second year. Written comprehensive examinations are required in two applied fields chosen by the student. Students must satisfactorily complete courses in econometrics and in a third field. The latter may be outside of economics.

The Department of Economics has no formal foreign language or communication skill requirement. The student, however, is expected to display a high degree of proficiency in written and spoken English and is encouraged to pursue additional training in foreign languages, technical writing, mathematics, statistics, and computer science as will support dissertation and career goals.

Other Relevant Information

Students in this program may elect the dual-title degree program option in Operations Research for the Ph.D. and M.A. degrees. The nonthesis option is available for the M.A. degree.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

ECONOMICS (ECON)

- 400M. HONORS SEMINAR IN ECONOMICS (3–12)
- 401. HISTORY OF ECONOMIC THOUGHT I (3)
- 402. DECISION MAKING AND STRATEGY IN ECONOMICS (3)
- 404W. CURRENT ECONOMIC ISSUES (3)
- 405. SEMINAR IN ECONOMIC ANALYSIS (3)
- 412. LABOR MARKET POLICY AND COLLECTIVE BARGAINING (3)
- 423. STATE AND LOCAL TAXATION (3)
- 424. INCOME DISTRIBUTION (3)
- 425. ECONOMICS OF PUBLIC EXPENDITURES (3)
- 427. (EDADM) ECONOMICS OF EDUCATION (3)
- 428. ENVIRONMENTAL ECONOMICS (3)
- 429. PUBLIC FINANCE AND FISCAL POLICY (3)
- 432. URBAN ECONOMICS (3)
- 433. ADVANCED INTERNATIONAL TRADE THEORY AND POLICY (3)
- 434. INTERNATIONAL FINANCE AND OPEN ECONOMY MACROECONOMICS (3)
- 435. BLACK AMERICAN ECONOMIC DEVELOPMENT (3)
- 436. (DF) ECONOMICS OF DISCRIMINATION (3)
- 443. ECONOMICS OF LAW AND REGULATION (3)
- 444. ECONOMICS OF THE CORPORATION (3)
- 445. (H P A) HEALTH ECONOMICS (3)
- 450. THE BUSINESS CYCLE (3)
- 451. MONETARY THEORY AND POLICY (3)
- 462. AMERICAN ECONOMIC DEVELOPMENT (3)
- 463. ECONOMIC DEMOGRAPHY (3)
- 471. GROWTH AND DEVELOPMENT (3)
- 474. EAST ASIAN ECONOMIES (3)
- 480. MATHEMATICAL ECONOMICS (3)
- 489M. HONORS THESIS (1–6)

490. INTRODUCTION TO ECONOMETRICS (3)
494. RESEARCH PROJECT (1–12)
495. INTERNSHIP (1–18)
496. INDEPENDENT STUDIES (1–18)
497. SPECIAL TOPICS (1–9)
499. FOREIGN STUDY—ECONOMICS (2–6)
500. INTRODUCTION TO MATHEMATICAL ECONOMICS (3) Applications of mathematical techniques to economics.
501. ECONOMETRICS (3) Applications of statistical techniques to economics.
502. MICROECONOMIC ANALYSIS (3) Economic behavior under pure and imperfect competition; price and output determination in product markets; prices and employment in factor markets.
503. MACROECONOMIC ANALYSIS (3) National income accounts; determination of income, employment, interest rates, and the price level; stabilization policy.
506. PROBLEMS IN ECONOMICS (1–12) Planned projects involving library, laboratory, or field work.
507. INTERNATIONAL TRADE (3–6) Theory of international trade and investment; effect of commercial policy on trade and income distribution; multinational corporations and international trade.
510. (AG EC) ECONOMETRICS I (3) General linear model, multicollinearity, specification error, autocorrelation, heteroskedasticity, restricted least squares, functional form, dummy variables, limited dependent variables. Prerequisite: ECON 501, STAT 462, or 501.
511. (AG EC) ECONOMETRICS II (3) Stochastic regressors, distributed lag models, pooling cross-section and time-series data, simultaneous equation models. Prerequisite: ECON (AG EC) 510.
515. LABOR ECONOMICS I (3) Labor supply and income maintenance; human capital, job search and training; labor demand, minimum wage, and discrimination.
516. LABOR ECONOMICS II (3) Earnings differentials, unemployment, and related policy. Institutional aspects of labor economics, including dual labor markets, collective bargaining, and unionism.
517. OPEN ECONOMY MACROECONOMICS AND INTERNATIONAL FINANCE (3–6) The balance of payments, portfolio allocation, monetary and fiscal policy in an open economy, exchange rate regimes, selected policy issues.
521. ADVANCED MICROECONOMIC THEORY (3–6) Theory of consumer behavior; theory of the firm; price determination in product and factor markets; introduction to welfare economics.
522. ADVANCED MACROECONOMIC THEORY (3–6) Measurement of income; theories of consumption, investment, and money holdings; static determination of income and employment; introduction to dynamic analysis.
524. APPLIED WELFARE ECONOMICS AND INCOME DISTRIBUTION (3–6) Public resource allocation problems; alternative collective policies and organizations; income and wealth distribution; measuring inequality; income dynamics; poverty; public policy.
525. TECHNOLOGICAL CHANGE AND RESEARCH AND DEVELOPMENT POLICY (3) Theoretical, empirical, and policy analysis of investments in research and development; effects of research and development on profitability, economic growth, international competition.
529. PUBLIC FINANCE (3–6) Effects of taxes, expenditures, debt on allocation, employment, distribution; cost-benefit analysis; collective decision mechanisms; fiscal federalism; current fiscal policy problems.
532. URBAN ECONOMICS (3) Urban structure; migration of capital and households; urban public finance.
543. INDUSTRIAL ORGANIZATION AND PUBLIC POLICY (3–6) The structure of American industry; performance and behavior; public policies toward business.
550. ECONOMIC FLUCTUATIONS (3) Analysis of the various theories of economic fluctuations; their methodological premises.
558. DEVELOPMENT OF MONETARY THEORY (3) Classical and neoclassical quantity theories of money and contemporary criticism; Keynesian monetary theory and its critics.
559. CURRENT MONETARY THEORY AND POLICY (3) Post-Keynesian reformulation of quantity and Keynesian theories of money; liquidity and general equilibrium approaches; current issues in theory and policy.
570. DEVELOPMENT ECONOMICS (3–6) Resources and institutions; quantitative measures; theories of economic growth in developing areas; developmental policies.
571. ECONOMICS OF TRANSITION (3–6) Problems of transition to a market economy. Economic problems of former Soviet-type economies. Economics of privatization, stabilization, and restructuring.
572. SOVIET AND OTHER CENTRALLY PLANNED ECONOMIES (3–6) Principles, structure, and performance of centrally planned economies, with special emphasis on the Soviet Union.

589. (AG EC) SEMINAR IN ECONOMETRIC THEORY (3–6) Theories and methods relevant to the application of statistical methods to economics. Prerequisite: ECON (AG EC) 510, 511.

596. INDIVIDUAL STUDIES (1–9)

597. SPECIAL TOPICS (1–9)

EDUCATIONAL ADMINISTRATION (EDADM)

DONALD J. WILLOWER, *In Charge of Graduate Programs in Educational Administration*

300 Rackley Building

814-865-1487

Degrees Conferred: Ph.D., D.Ed., M.S., M.Ed.

The Graduate Faculty

William Lowe Boyd, Ph.D. (Chicago) *Distinguished Professor of Education*

William T Hartman, Ph.D. (Stanford) *Professor of Education*

Susan C. Reis, J.D., Ph.D. (Ohio State) *Assistant Professor of Education*

Roger C. Shouse, Ph.D. (Chicago) *Assistant Professor of Education*

John W. Tippeconnic III, Ph.D. (Penn State) *Professor of Education*

Seldon V. Whitaker, Ed.D. (Northeastern) *Adjunct Associate Professor of Education*

Donald J. Willower, Ed.D. (Buffalo) *Distinguished Professor of Education*

Graduate work in Educational Administration is available to those who want to exercise leadership roles in educational policy and management or engage in research. Among those roles are principals, supervisors, and superintendents of public and independent schools, intermediate unit officials, state and federal agency administrators and staff, professors of educational administration, and research and development personnel. Special areas of research are organization theory, school law, negotiations, personnel and staff development, economics and finance in education, application of modern technology, leadership, politics of education, philosophical issues in educational administration, and international comparative educational administration. Internships and practicums in a variety of settings can be arranged.

Admission Requirements

Scores from the Miller Analogies Test (MAT) are required for admission to the doctoral programs in Educational Administration. When the MAT is not available (e.g., some overseas locations), Graduate Record Examination (GRE) scores may be substituted. At the discretion of a graduate program, a student may be admitted provisionally. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.

Applicants to the M.Ed. and M.S. degree programs must present evidence of at least a 2.60 grade-point average in the last two years of undergraduate work. A grade-point average of 3.50 in prior graduate work is required of those desiring admission to enter a doctoral program. The best-qualified students will be accepted up to the number of spaces available. Special backgrounds and experiences may allow for conditional admission to those not meeting stated criteria.

More details concerning the degree and certification programs are presented in a prospectus that is available upon request.

Master's Degree and Certification Requirements

All candidates for the M.Ed. and M.S. degrees will complete a minimum of 30 graduate credits. Certification for various public school administrative positions requires additional graduate work beyond the master's degree and such requirements as specified in the program prospectus.

M.Ed. students must submit a master's paper. M.S. degree students are expected to submit a thesis.

Doctoral Degree Requirements

Candidates for the D.Ed. degree are required to spend at least one semester and one summer session consecutively in full-time residence during a twelve-month period. Ph.D. candidates are strongly encouraged to spend two academic years in residence, but must spend at least two consecutive semesters in residence. D.Ed. candidates may satisfy the residence requirement in another manner consistent with Graduate School policy, including attendance at the day-long seminars offered weekly every other academic year. Candidates for all degrees are required to combine work in the social sciences and humanities with the specialization in Educational Administration.

Expectations of candidates for both the D.Ed. and Ph.D. are high in the field of research competence and require the ability to identify and conceptualize a research problem for the thesis. The D.Ed. is more appropriate for those with career goals in administration and policy making. The Ph.D. is more appropriate for those with career goals in research and scholarship.

After the doctoral student has been admitted to a doctoral program and has completed forty to forty-five hours beyond the bachelor's degree, his or her name is usually submitted for candidacy. After a student is admitted to candidacy for the doctoral degree, he or she takes the comprehensive written and oral examinations. After those are successfully completed, the student presents a thesis problem on a significant, researchable topic, evidenced by a prospectus to the doctoral committee for review.

Other Relevant Information

American Indian students participate in a special administrator preparation program. Foreign students can work on research topics in their home nations.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

EDUCATIONAL ADMINISTRATION (EDADM)

427. (ECON) ECONOMICS OF EDUCATION (3)

476. THE TEACHER AND THE LAW (3)

480. INTRODUCTION TO EDUCATIONAL ADMINISTRATION (2-3)

481. COLLECTIVE BARGAINING IN EDUCATION (3)

485. PRINCIPAL AS INSTRUCTIONAL LEADER (3)

496. INDEPENDENT STUDIES (1-18)

497, 498. SPECIAL TOPICS (1-9)

528. EDUCATIONAL POLITICS IN THE UNITED STATES (3) Social and institutional forces that shape the public school system and determine national, state, and local educational policy and politics.

533. THE POLITICS OF LOCAL SCHOOL DISTRICTS (3) Theory and practice of the politics and governance of local school districts; issues and methods in studying political decision making. Prerequisite: 6 credits of sociology, anthropology, or political science.

565. PERSONNEL MANAGEMENT AND CONTRACT ADMINISTRATION (2-3) Practice and theory of personnel supervision at the central office and building level, including contract administration and grievance handling. Prerequisites: 18 credits in education and three years' teaching experience.

566. EDUCATION POLICY AND POLITICS (3) The political economy and bureaucratic politics of educational organizations, with special attention to the policy-making, implementation, and evaluation processes. Prerequisite: EDADM 528 or 533.

567. ORGANIZATIONAL SUPERVISION (3) Principles and practices of supervision in schools related to instructional and support personnel. Prerequisites: EDADM 480, teaching experience.

568. THE PRINCIPALSHIP (2-3) Principles and practices of administration of elementary and secondary schools.

569. DECISION MAKING IN EDUCATIONAL ORGANIZATIONS (2-3) Decision making in organizational and environmental contexts; case studies of administrative problems; application of decision-making models. Prerequisite: EDADM 480.

571. EDUCATIONAL FACILITIES PLANNING (2-3) Educational facilities planning, including use of demographic, curriculum, resource, energy data, and state building construction guidelines. Prerequisite: EDADM 480, teaching, administrative, or supervisory experience.

573. PUBLIC SCHOOL FINANCE (2-3) Financing of public education in relation to organization and control; the conceptual basis for local financial administration; taxation, state and federal aid, school revenue, and money management. Prerequisite: EDADM 480 or teaching or administrative or supervisory experience.

574. THEORY AND CURRENT ISSUES IN PUBLIC BARGAINING (2-3) Theories of bargaining; legal basis for public bargaining; state and federal labor relations agencies; supervisory bargaining. Prerequisite: EDADM 481 or administrative experience.

576. THE LAW AND EDUCATION (3) Legal bases for education; rights and responsibilities of school board member, administrators, teachers, students, and parents; due process. Prerequisite: EDADM 480 or teaching or administrative or supervisory experience.

578. SCHOOLS AS ORGANIZATIONS (2-3) Intraorganizational relationships; administration and the school in its organizational and environmental contexts. Prerequisite: EDADM 480 or teaching or administrative or supervisory experience.

579. **PUBLIC SCHOOL BUSINESS ADMINISTRATION (2–3)** Business management applied to school management problems; budgeting, accounting, purchasing, insurance, school equipment, cafeteria management; transportation, salaries, personnel management, and auxiliary and coordinate agencies. Prerequisites: EDADM 480 or teaching or administrative or supervisory experience; EDADM 573.
580. **THE USE OF THEORY IN EDUCATIONAL ADMINISTRATION (1–6)** Critical analysis of current theories; problem finding and hypothesis formulation. Prerequisites: EDADM 480; 6 credits in educational administration.
581. **FIELD RESEARCH IN EDUCATIONAL ADMINISTRATION (2–3)** Field study and qualitative methods in research on educational organizations. Prerequisites: EDADM 480; 6 credits in educational administration.
583. **CURRENT ADMINISTRATIVE PRACTICE (3)** Practice-oriented skills and experiences facilitating effective administration. Prerequisite: EDADM 480.
584. **EVALUATION IN EDUCATIONAL ORGANIZATIONS (3)** Naturalistic and empirical evaluation methods and procedures for educational organizations. Prerequisites: a course in educational administration; a course in basic statistics.
594. **SEMINAR IN SCHOOL LAW (3)** Research in substantive issues in school law. Prerequisite: EDADM 576.
595. **INTERNSHIP IN ADMINISTRATION AND SUPERVISION (1–15)** Guided experience in a school or other educational organization in which the student is not regularly employed, under supervision of a graduate faculty member. Prerequisites: EDADM 480, teaching experience, and a professional certificate.
596. **INDIVIDUAL STUDIES (1–9)**
597. **SPECIAL TOPICS (1–9)**

EDUCATIONAL PSYCHOLOGY (EDPSY)

ROBERT L. HALE, *Head of the Department of Educational and School Psychology and Special Education*

227 CEDAR Building
814-865-6072

ROBERT J. STEVENS, *In Charge of Graduate Programs in Educational Psychology*

202 CEDAR Building
814-863-2417

Degrees Conferred: Ph.D., M.S.

The Graduate Faculty

Jeanne T. Amlund, Ph.D. (Arizona State) *Assistant Professor of Educational Psychology*

Joseph L. French, Ed.D. (Nebraska) *Professor Emeritus of Education*

Robert L. Hale, Ph.D. (Nebraska) *Professor of Education*

Edmond Marks, Ph.D. (Penn State) *Senior Research Associate; Affiliate Associate Professor of Educational Psychology*

Bonnie J. F. Meyer, Ph.D. (Cornell) *Professor of Educational Psychology*

María Penneck Román, Ph.D. (California, Berkeley) *Assistant Professor of Education*

Dennis M. Roberts, Ed.D. (Florida State) *Professor of Educational Psychology*

Barbara A. Schaefer, Ph.D. (Pennsylvania) *Assistant Professor of Education*

Robert J. Stevens, Ph.D. (Illinois) *Associate Professor of Educational Psychology*

Hoi K. Suen, Ed.D. (Northern Illinois) *Professor of Educational Psychology*

Peggy Van Meter, Ph.D. (Maryland) *Assistant Professor of Education*

Educational Psychology is a subset within psychology that focuses primarily on human behavior, especially as it relates to learning and evaluation in instructional settings and situations. Applied Cognitive Studies in Instruction and Learning encompasses applications of cognitive psychology to education, instruction, and learning across the lifespan. Primary foci are on teaching and research in universities, public schools, state departments of education, industry, the military, or other training settings. Courses of study provide a foundation in psychological theories and principles and specializations related to cognition, thinking, and higher mental processes. The Educational and Psychological Measurement Option focuses on research methodology with an emphasis in educational and psychological measurement as it relates to test design, instrument construction, scale analysis, and measurement theory. Persons

working in this area typically have strong interests in supporting areas of statistics and research design, computer applications, and/or mathematics.

Admission Requirements

Applicants are required to submit scores from the Graduate Record Examination (GRE). Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Students with a 3.00 junior/senior grade-point average (on a 4.00 scale) and a broad undergraduate background, including some college mathematics, will be considered for admission. Exceptions to the minimum 3.00 average may be made for students with special backgrounds, abilities, and interests. Applicants with a master's degree will be required to show more than minimum success in graduate study, including at least one-half of their graduate credits of A quality. The best-qualified applicants will be accepted up to the number of spaces that are available for new students.

Master's Degree Requirements

There are two options in the master's program. A thesis option and the M.S. without thesis may be taken in learning or measurement. The M.S. with thesis is required for Ph.D. candidates. Other areas of study related to educational psychology, such as counseling and guidance, clinical psychology, and school psychology are offered in other departments of the University. The following courses, or their equivalents taken within the last five years, should be represented in the student's program prior to the evaluation for the M.S. degree and Ph.D. candidacy: EDPSY 406, 421, 450, and 475.

Doctoral Degree Requirements

Doctoral degree requirements include a major emphasis in one of the two areas of educational psychology (learning or measurement) with minor emphasis in another. The doctoral program of study includes those courses specified for a master's program and at least one course in educational or philosophical foundations. In lieu of the foreign language requirement for the Ph.D. degree, students are expected to present to the committee a statement of objectives and goals and plan of the academic and nonacademic work to be undertaken in achieving these goals, as detailed in the student handbook. Within the context of the above, the students are expected to incorporate relevant experiences to increase their effectiveness as educational psychologists.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

EDUCATIONAL PSYCHOLOGY (EDPSY)

400. INTRODUCTION TO STATISTICS IN EDUCATIONAL RESEARCH (3)

406. APPLIED STATISTICAL INFERENCE FOR THE BEHAVIORAL SCIENCES (3)

421. LEARNING PROCESSES IN RELATION TO EDUCATIONAL PRACTICES (3)

450. (PSY) PRINCIPLES OF MEASUREMENTS (3)

475. INTRODUCTION TO EDUCATIONAL RESEARCH (3)

496. INDEPENDENT STUDIES (1-18)

497, 498. SPECIAL TOPICS (1-9)

506. ADVANCED TECHNIQUES FOR ANALYZING EDUCATIONAL EXPERIMENTS (3) Analytical and experimental control considerations for designs involving nested and/or crossed subjects. Analysis of variance and multiple comparison via computers. Prerequisite: EDPSY 406 or PSY 415.

507. MULTIVARIATE PROCEDURES IN EDUCATIONAL RESEARCH (3) Introduction to matrix algebra, computer programming, multiple regression analysis, multiple and canonical correlation, multiple discriminant analysis, classification procedures, factor analysis. Prerequisite: EDPSY 406 or PSY 415.

512. GROUP PROCESSES IN THE CLASSROOM (3) Basic concepts and perspectives in the study of group processes; instructional group interaction; analysis of classroom behavior.

513. INDIVIDUAL AND GROUP DIFFERENCES (3) Description, causes, and interpretation of individual variation over the life span, with application to school and institutional practices. Prerequisite: EDPSY 400 or 450.

523. CONCEPT LEARNING AND PROBLEM SOLVING (3-4) Theoretical-empirical trends in concept learning, problem solving, and creativity related to instructional psychology. Prerequisite: EDPSY 421.

524. THEORIES OF LEARNING AND INSTRUCTION (3) Study of major classical theories of learning and recent developments in learning and instructional theory. Prerequisite: EDPSY 421.

526. (LL ED) THE PSYCHOLOGY OF READING (3) Psychological principles underlying the process of reading and comprehending, with application to instruction. Prerequisite: EDPSY 421.
527. PSYCHOLOGY OF ADULTS AS LEARNERS (3) Psychological principles related to learning by adults, with application to instruction and other educational practices. Prerequisite: EDPSY 421.
528. INSTRUCTIONAL PSYCHOLOGY (3) Application to instructional design of current developments in research on human development, information processing, learning strategies, memory structures, instructional processes. Prerequisite: EDPSY 421.
550. DESIGN AND CONSTRUCTION OF PSYCHOLOGICAL MEASURES (3) Lecture-practicum involving planning, construction, administration, and analysis of a psychological test; lectures stress construct validity, item analysis, and predictive validity. Prerequisite: EDPSY 450.
554. THEORIES OF PSYCHOLOGICAL MEASUREMENT (3) Basic true-score and error models; their extensions to test reliability and test validity; problems of item analysis and weighting. Prerequisite: EDPSY 450.
555. VALIDITY OF ASSESSMENT RESULTS (3) Concepts, issues, and methods of validation of educational and psychological assessment including models and approaches to validation, bias, and utility. Prerequisites: EDPSY, 406, 450.
560. CONTEMPORARY ISSUES IN THE EVALUATION OF EDUCATIONAL PROGRAMS (3) Practical and theoretical issues in the planning, execution, and interpretation of program evaluations. Prerequisites: EDPSY 450, 475.
575. SEMINAR IN EDUCATIONAL PSYCHOLOGY (1-6) A seminar dealing with specific topics in educational psychology. Open to advanced students in the behavioral sciences.
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

EDUCATIONAL THEORY AND POLICY (EDTHP)

Graduate Programs in Educational Theory and Policy
300 Rackley Building
814-865-1488

Degrees Conferred: Ph.D., M.A.

The Graduate Faculty

David P. Baker, Ph.D. (Johns Hopkins) *Professor of Education*
William L. Boyd, Ph.D. (Chicago) *Distinguished Professor of Education*
David Gamson, Ph.D. (Stanford) *Assistant Professor of Education*
Aaron D. Gresson III, Ph.D. (Boston College); Ph.D. (Penn State) *Associate Professor of Education*
Gerald K. LeTendre, Ph.D. (Stanford) *Assistant Professor of Education*
Suet-Ling Pong, Ph.D. (Chicago) *Associate Professor of Education*
David M. Post, Ph.D. (Chicago) *Associate Professor of Education*
Madhu S. Prakash, Ph.D. (Syracuse) *Professor of Education*

The master's and doctoral programs in Educational Theory and Policy are designed primarily to prepare persons for careers in education policy development and analysis. Students in the program may choose to emphasize policy development and analysis either in the United States or in terms of a comparative and international perspective. Additionally, individualized multidisciplinary programs of study in the foundation areas of education (history, philosophy, sociology, and comparative/international) and in the social sciences, management sciences, and/or humanities will be designed jointly by the student and the program faculty. It is anticipated that graduates will find employment in state departments of education, ministries of education, federal and international education agencies, academic institutions, and various professional associations.

Admission Requirements

Scores from the Graduate Record Examination (GRE) or from the Miller Analogies Test (MAT) are required for admission. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Students with a 2.75 grade-point average will be considered for admission to the master's program, and with a 3.50 grade-point average at the master's level for the Ph.D. program. Exceptions to

the minimum grade-point average may be made for students with special backgrounds, abilities, and interests.

Master's Degree Requirements

Candidates who seek an M.A. in Educational Theory and Policy shall complete programs that will include studies in social theory, policy, and planning or in the social sciences or humanities. A thesis is required.

Doctoral Degree Requirements

Candidates who seek a Ph.D. in Educational Theory and Policy shall complete programs that will include studies in social theory, policy, and planning, or in the social sciences or humanities.

All doctoral students must pass a written and oral candidacy examination after nine to eighteen hours of study.

Candidates for the Ph.D. degree are required to complete a minimum of two consecutive semesters in residence during an academic year.

The communication and foreign language requirements for the Ph.D. degree may be satisfied by options selected from foreign languages, statistics, computer science, logic, or other research methodologies deemed acceptable by the candidate's doctoral committee.

At the end of the program of study, each student must take a written comprehensive examination that will cover the student's major areas of study.

Other Relevant Information

Upon admission, each student will be assigned to a faculty adviser whose specialization best coincides with the student's background or academic interest. For the master's degree, the adviser and student together will plan the program of study. For doctoral students, the adviser and student will plan the early aspects of study, but an interdisciplinary committee will be formed, soon after the student is admitted to candidacy, to supervise completion of a program of study.

Student Aid

Graduate assistantships available to doctoral students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

EDUCATIONAL THEORY AND POLICY (EDTHP)

401. INTRODUCTION TO COMPARATIVE EDUCATION (3)

404. EDUCATION IN AFRICA (3)

405. EDUCATION IN ASIA (3)

406. EDUCATION IN EUROPE (3)

407. EDUCATION IN LATIN AMERICA AND THE CARIBBEAN (3)

411. ETHNIC MINORITIES AND SCHOOLS IN THE UNITED STATES (3)

412. (WMNST) EDUCATION AND THE STATUS OF WOMEN (3)

416. (SOC) SOCIOLOGY OF EDUCATION (3)

430. HISTORY OF EDUCATION IN THE UNITED STATES (3)

440. INTRODUCTION TO PHILOSOPHY OF EDUCATION (3)

441. EDUCATION, SCHOOLING, AND VALUES (3)

496. INDEPENDENT STUDIES (1-18)

497, 498. SPECIAL TOPICS (1-9)

500. PROSEMINAR IN EDUCATIONAL THEORY AND POLICY (1) An introduction to disciplinary and interdisciplinary studies in educational theory and policy.

501. EDUCATION IN DEVELOPING COUNTRIES (3) The meaning of development and the role of education in the development process: theories, agents, trends, and case studies.

502. EDUCATIONAL PLANNING TECHNIQUES IN DEVELOPING COUNTRIES, PART I (3) The introduction of systematic analysis, methodologies, and analytical techniques of education programs and projects to aid decision making in educational planning.

504. RURAL EDUCATION IN DEVELOPING NATIONS (3) Analysis of the rural societies, education, and change in the rural sector of developing nations.

505. NATIONALITY POLICY AND EDUCATION (3) Education and national integration; problems of cultural dominance in multinational states.

506. (CI ED 502, HI ED 506) EDUCATIONAL MOBILITY IN COMPARATIVE PERSPECTIVE (3) Role of education in social mobility, using quantitative, qualitative, and historical methods; focuses comparatively on Britain, East Asia, and South America.

507. (CI ED 503, HI ED 503) **ETHNICITY, NATIONAL IDENTITY, AND EDUCATION** (3) Surveys group-oriented education policies internationally, especially comparing those of Britain, Taiwan, India.
511. **EDUCATION AND POLITICAL SOCIALIZATION** (3) An examination of the studies that examine the function of schools in socializing the young for adult political roles.
512. **EDUCATION AND THE SOCIAL STRUCTURE** (3) An examination of the relationships between educational opportunities and social structure.
514. **SOCIAL CHANGE, CULTURAL DYNAMICS, AND EDUCATION** (3) The role of the school in promoting either social change or stability.
516. (CI ED) **EDUCATION AND DEMOGRAPHIC CHANGE IN THE UNITED STATES AND ABROAD** (3) Interrelationship among schooling and employment, marriage, fertility, and migration. Focus comparatively on the United States and developing countries.
518. **ANALYSIS OF U.S. EDUCATIONAL POLICY** (3) The interaction between educational theory and social structure, focusing on the role of practicing intellectuals in contemporary institutional settings.
530. **THE DEVELOPMENT OF THE AMERICAN SCHOOL** (3) American schooling critically examined institutionally from a historical perspective in social-cultural context. Emphasis on theories of interpretation and change.
531. **STUDIES IN WESTERN EDUCATIONAL THOUGHT TO 1500** (3) General review and critical examination of selected Western educational ideas and movements from pre-Classical, Classical, Medieval, and early Renaissance periods.
533. **SOCIAL HISTORY AND EDUCATION POLICY** (3) Historical study of social dimensions in the formation of education policy.
536. **STUDIES IN EDUCATIONAL THOUGHT** (3) Studies in the historical development of educational theory.
537. **HISTORY OF AMERICAN INDIAN EDUCATION POLICY** (3) Focusing on the relationship between American Indians and the United States, this course examines historical and contemporary federal education policy.
540. **DEWEY AND THE PRAGMATIC-INSTRUMENTALIST EDUCATIONAL TRADITION** (3) Critical examination of John Dewey's educational thought in the context of pragmatic philosophy and progressivism in American education.
541. **CONTEMPORARY PHILOSOPHIES OF EDUCATION** (3) Educational theory and practice in relation to contemporary movements in philosophy.
596. **INDIVIDUAL STUDIES** (1-9)
597. **SPECIAL TOPICS** (1-9)

ELECTRICAL ENGINEERING (E E)

JOHN D. MITCHELL, *Interim Head of the Department of Electrical Engineering*
129 Electrical Engineering East
814-863-2788

Degrees Conferred: Ph.D., M.S., M.Eng.

The Graduate Faculty

William S. Adams, Ph.D. (Penn State) *Professor Emeritus of Electrical Engineering*
S. Ashok, Ph.D. (Rensselaer) *Professor of Engineering Science*
Kultegin Aydin, Ph.D. (METU, Ankara) *Associate Professor of Electrical Engineering*
Osama O. Awadelkarim, Ph.D. (Reading, England) *Associate Professor of Engineering Science and Mechanics*
Amar S. Bhalla, Ph.D. (Penn State) *Professor of Materials and Electrical Engineering*
Nirmal K. Bose, Ph.D. (Syracuse) *HRB Systems Professor of Electrical Engineering*
James K. Breakall, Ph.D. (Case Western Reserve) *Professor of Electrical Engineering*
John L. Brown, Jr., Ph.D. (Brown) *Professor Emeritus of Electrical Engineering*
Larry C. Burton, Ph.D. (Penn State) *Professor of Electrical and Computer Engineering*
Octavia I. Camps, Ph.D. (Washington) *Assistant Professor of Electrical Engineering*
Lynn A. Carpenter, Ph.D. (Illinois) *Associate Professor of Electrical Engineering*
Lee D. Coraor, Ph.D. (Iowa) *Associate Professor of Electrical Engineering*
Charles L. Croskey, Ph.D. (Penn State) *Professor of Electrical Engineering*
Leslie E. Cross, Ph.D. (Leeds) *Evan Pugh Professor of Electrical Engineering*
Chitaranjan Das, Ph.D. (S.W. Louisiana) *Associate Professor of Computer Engineering*

- Mukunda B. Das, Ph.D., D.I.C. (London) *Professor Emeritus of Electrical Engineering*
John F. Doherty, Ph.D. (Rutgers) *Associate Professor of Electrical Engineering*
Joseph P. Dougherty, Ph.D. (Penn State) *Senior Research Associate and Associate Professor of Materials and Electrical Engineering*
John E. Dzielski, Ph.D. (MIT) *Research Associate*
Tse-yun Feng, Ph.D. (Michigan) *Binder Professor of Computer Engineering*
Anthony J. Ferraro, Ph.D. (Penn State) *Professor of Electrical Engineering*
Steven J. Fonash, Ph.D. (Pennsylvania) *Alumni Professor and Professor of Engineering Science*
David B. Geselowitz, Ph.D. (Pennsylvania) *Professor of Bioengineering*
Gennady Sh. Gildenblat, Ph.D. (Rensselaer) *Professor of Electrical Engineering*
Dale M. Grimes, Ph.D. (Michigan) *Professor Emeritus of Electrical Engineering*
Ruyan Guo, Ph.D. (Penn State) *Associate Professor of Materials and Electrical Engineering*
Leslie C. Hale, Ph.D. (Carnegie Inst of Tech) *Professor Emeritus of Electrical Engineering*
David L. Hall, Ph.D. (Penn State) *Senior Research Associate; Professor of Electrical Engineering*
William E. Higgins, Ph.D. (Illinois) *Professor of Electrical Engineering*
Thomas W. Hilands, Ph.D. (Penn State) *Research Associate*
Paul T. Hulina, Ph.D. (Penn State) *Associate Professor Electrical Engineering*
Ali R. Hurson, Ph.D. (Florida) *Associate Professor of Computer Engineering*
Thomas N. Jackson, Ph.D. (Michigan) *Professor of Electrical Engineering*
Timothy J. Kane, Ph.D. (Illinois) *Assistant Professor of Electrical Engineering*
Rangachar Kasturi, Ph.D. (Texas Tech) *Professor of Electrical Engineering*
Mohsen Kavehrad, Ph.D. (Polytechnic Univ) *William L. Weiss Professor of Electrical Engineering*
Donald E. Kerr, Ph.D. (Penn State) *Senior Research Associate*
Iam-Choon Khoo, Ph.D. (Rochester) *Professor of Electrical Engineering*
Stewart K. Kurtz, Ph.D. (Ohio State) *Murata Professor of Materials Research and Professor of Electrical Engineering*
Kwang Y. Lee, Ph.D. (Michigan State) *Professor of Electrical Engineering*
Raymond J. Luebbers, Ph.D. (Ohio State) *Professor of Electrical Engineering*
John D. Mathews, Ph.D. (Case Western Reserve) *Professor of Electrical Engineering*
Jeffrey S. Mayer, Ph.D. (Purdue) *Associate Professor of Electrical Engineering*
Theresa S. Mayer, Ph.D. (Purdue) *Assistant Professor of Electrical Engineering*
George J. McMurtry, Ph.D. (Purdue) *Professor Emeritus of Electrical Engineering*
John J. Metzner, Eng. Sc. D. (New York) *Professor of Computer Engineering*
David J. Miller, Ph.D. (California, Santa Barbara) *Assistant Professor of Electrical Engineering*
David L. Miller, Ph.D. (Illinois) *Professor of Electrical Engineering*
John D. Mitchell, Ph.D. (Penn State) *Professor of Electrical Engineering*
John S. Nisbet, Ph.D. (Penn State) *Alumni Professor Emeritus of Electrical Engineering*
Simin Pakzad, Ph.D. (Oklahoma) *Associate Professor of Computer Engineering*
Jay S. Patel, Ph.D. (SUNY at Stony Brook) *Professor of Physics, Electrical Engineering, and Materials Research*
C. Russell Philbrick, Ph.D. (North Carolina State) *Professor of Electrical Engineering*
Shashi Phoha, Ph.D. (Michigan State) *Senior Scientist and Professor of Electrical and Computer Engineering*
Asok Ray, Ph.D. (Northeastern) *Professor of Mechanical Engineering*
James W. Robinson, Ph.D. (Michigan) *Professor of Electrical Engineering*
William J. Ross, Ph.D. (New Zealand) *Professor Emeritus of Electrical Engineering*
Christopher S. Ruf, Ph.D. (Massachusetts) *Associate Professor of Electrical Engineering*
David W. Russell, Ph.D. (Manchester) *Professor of Electrical Engineering, Great Valley*
Jerzy Ruzyllo, Ph.D. (Technical Univ. of Warsaw) *Professor of Electrical Engineering*
Jeffrey L. Schiano, Ph.D. (Illinois) *Assistant Professor of Electrical Engineering*
Leon H. Sibul, Ph.D. (Penn State) *Senior Scientist; Professor of Acoustics*
Jack J. Stein, Dr.Eng.Sci. (NYU) *Associate Professor of Electrical Engineering, Great Valley*
Frank W. Symons, Ph.D. (Penn State) *Senior Research Associate*
Mario Szaiaer, Ph.D. (Washington) *Associate Professor of Electrical Engineering*
Richard L. Tutwiler, Ph.D. (Penn State) *Research Associate*
Kenji Uchino, Ph.D. (Tokyo Institute of Technology) *Professor of Electrical Engineering*
Robert Van Dyck, Ph.D. (North Carolina State) *Assistant Professor of Electrical Engineering*
Vasundara V. Varadan, Ph.D. (Illinois) *Distinguished Alumni Professor of Engineering Science and Mechanics and Electrical Engineering*
Vijay K. Varadan, Ph.D. (Northwestern) *Distinguished Alumni Professor of Engineering Science and Mechanics and Electrical Engineering*

Douglas H. Werner, Ph.D. (Penn State) *Associate Professor of Electrical Engineering*
 Pingjuan L. Werner, Ph.D. (Penn State) *Associate Professor of Electrical Engineering*
 Christopher R. Wronski, Ph.D. (Imperial College, London) *Leonhard Professor of Microelectronic
 Devices and Materials*
 Shudong Wu, Ph.D. (Penn State) *Senior Research Associate*
 Shizhuo Yin, Ph.D. (Penn State) *Assistant Professor of Electrical Engineering*
 Randy K. Young, Ph.D. (Penn State) *Senior Research Associate*
 Francis T. S. Yu, Ph.D. (Michigan) *Evan Pugh Professor of Electrical Engineering*
 Qiming Zhang, Ph.D. (Penn State) *Associate Professor of Electrical Engineering*

The principal areas of graduate research in Electrical Engineering are communications, control systems, electromagnetics, electro-optics, electronic materials and devices, power systems, signal and image processing, and space sciences and instrumentation.

For information about areas of specialization, laboratory and research facilities, fellowships, assistantships, and other sources of financial assistance, write directly to the Coordinator of Graduate Affairs, Department of Electrical Engineering, 121 Electrical Engineering East, University Park, PA 16802-2705, or contact us at www.ee.psu.edu on the Web.

Admission Requirements

Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*. Applicants are required to submit scores from the general portions of the Graduate Record Examination, two letters of reference, and a personal statement of relevant experience and goals.

Master of Science Degree Requirements

The Master of Science requirements include the general requirements of the Graduate School as listed under Master's Degree Requirements.

Specific course requirements: (1) Thesis option—24 course credits, with adequate attention to breadth, 2 colloquium credits, 6 thesis credits, and a satisfactory thesis; (2) Paper option—30 course credits, including a broad selection of 500-level courses, 2 colloquium credits, 2 paper credits, and a satisfactory paper.

Master of Engineering Degree Requirements

The Master of Engineering requirements include the general requirements of the Graduate School for such programs. The courses for the degree are offered through Penn State Great Valley, where program information may be obtained.

The degree requires 33 credits, which include 3 credits of E E 594 for the preparation of an M.Eng. professional paper. The remaining 30 credits consist of E E and CMPEN courses with at least 12 in E E and at least 15 at the 500 level. Students may substitute courses in related disciplines with the approval of the program coordinator.

Doctoral Degree Requirements

The Doctor of Philosophy requirements include the general requirements of the Graduate School as listed under Doctoral Degree Requirements.

Specific requirements: The communication requirement is met by adequacy in both spoken and written English. The candidacy examination consists of both written and oral parts, and the oral comprehensive examination is preceded by the writing of a thesis proposal. The program requires a minimum of 48 course credits and 2 colloquium credits beyond the B.S. degree.

Student Aid

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AID section of the *Graduate Bulletin*, the following awards typically have been available to graduate students in this program:

PAUL F. ANDERSON FELLOWSHIP—\$8,500 for one academic year. One year maximum.
 GTE FELLOWSHIP—Variable stipend plus tuition. One year maximum. For minority students.
 JAMES R. AND BARBARA R. PALMER FELLOWSHIP—\$5,500 per academic year. One year with possibility of renewal.
 JOSEPH R. AND JANICE M. MONKOWSKI GRADUATE FELLOWSHIP IN ELECTRICAL ENGINEERING—\$3,500 per academic year. One year with possibility of renewal.
 FRED C. AND M. JOAN THOMPSON GRADUATE FELLOWSHIP IN ELECTRICAL

ENGINEERING —\$5,000 per academic year. One year with possibility of renewal.
SOCIETY OF PENN STATE ELECTRICAL ENGINEERS (SPSEE) GRADUATE FELLOWSHIP—
\$6,000 per academic year. One year with possibility of renewal.

ELECTRICAL ENGINEERING (E E)

- 402W. PROJECTS IN ENGINEERING ELECTROMAGNETICS AND OPTICS (3)
- 403W. ELECTRONIC DESIGNS AND ANALOG AND DIGITAL INTERFACING (3)
- 407. (ENGR) TECHNOLOGY BASED ENTREPRENEURSHIP (3)
- 408. (ENGR) LEADERSHIP PRINCIPLES (2)
- 409. (ENGR) LEADERSHIP IN ORGANIZATIONS (3)
- 411. PRINCIPLES OF ELECTROMAGNETIC FIELDS (3)
- 412. OPTICAL FIBER COMMUNICATIONS (3)
- 413. LINEAR NETWORK ANALYSIS (3)
- 414. PRINCIPLES AND APPLICATIONS OF LASERS (3)
- 417. SYSTEM THEORY (3)
- 418. SOLID STATE DEVICE TECHNOLOGY (3)
- 419. SOLID STATE DEVICES (3)
- 420. ELECTRO OPTICS—PRINCIPLES AND DEVICES (3)
- 422. OPTICAL ENGINEERING LABORATORY (3)
- 423. POWER ELECTRONICS (3)
- 425. SYMMETRICAL COMPONENTS (3)
- 428. LINEAR CONTROL SYSTEMS (3)
- 429. INTRODUCTION TO DIGITAL CONTROL SYSTEMS (3)
- 432. UHF AND MICROWAVE ENGINEERING (3)
- 433. (METEO) FUNDAMENTALS OF REMOTE SENSING SYSTEMS (3)
- 438. ANTENNA ENGINEERING (3)
- 439. RADIOWAVE PROPAGATION IN COMMUNICATIONS (3)
- 447. (CSE) DIGITAL INTEGRATED CIRCUITS (3)
- 448. LINEAR ELECTRONIC DESIGN (3)
- 453. FUNDAMENTALS OF DIGITAL SIGNAL PROCESSING (3)
- 458. (CSE) DATA COMMUNICATIONS (3)
- 459. INTRODUCTION TO STATISTICAL THEORY OF COMMUNICATIONS (3)
- 461. FUNDAMENTALS OF POWER SYSTEM STABILITY (3)
- 485. (CSE) AN INTRODUCTION TO DIGITAL IMAGE PROCESSING (3)
- 486. (CSE) FUNDAMENTALS OF COMPUTER VISION (3)
- 490. (AERSP, NUC E) INTRODUCTION TO PLASMAS (3)
- 492. (AERSP, ASTRO) SPACE ASTRONOMY AND INTRODUCTION TO SPACE SCIENCE (3)
- 493. (ENGR) INDIVIDUAL LEADERSHIP EXPERIENCE (1)
- 494. SENIOR THESIS (1–9)
- 495. ENGINEERING LEADERSHIP SPECIAL PROJECT (1)
- 496. INDEPENDENT STUDIES (1–18)
- 497. SPECIAL TOPICS (1–9)

- 511. ENGINEERING ELECTROMAGNETICS (3) Electromagnetic field theory fundamentals with application to transmission lines, waveguides, cavities, antennas, radar, and radio propagation. Prerequisite: E E 411.
- 512. FIBER OPTICS AND INTEGRATED OPTICS (3) Theories and applications of linear and nonlinear optical phenomena in optical fibers and integrated optical devices. Prerequisite: E E 412.
- 518. MANUFACTURING METHODS IN MICROELECTRONICS (3) Methods, tools, and materials used to process advanced silicon integrated circuits. Prerequisite: E E 418.
- 519. SEMICONDUCTOR DEVICES (3) Characteristics and limitations of bipolar transistors, diodes, transmit time, and bulk-effect devices. Prerequisite: E E 419.
- 520. ELECTRO OPTICS—SYSTEMS AND COMPUTING (3) Synthetic aperture radar, spatial light modulators, optical interconnection, optical computing, neural networks, and medical optics imaging. Prerequisite: E E 420.
- 522. ELECTRO-OPTICS LABORATORY (3) Basic concepts and fundamental of light diffraction, optical signal processing, and holography. Prerequisite: E E 420.
- 524. LASERS AND OPTICAL ELECTRONICS (3) Study of several advanced nonlinear optical phenomena, laser propagation, optical and optoelectronic devices, principles, and applications. Prerequisite: E E 414.

527. **LINEAR CONTROL SYSTEMS (3)** Continuous and discrete-time linear control systems; state variable models; analytical design for deterministic and random inputs; time-varying systems stability. Prerequisites: E E 428 or M E 455; E E 417.
529. **OPTIMAL CONTROL (3)** Variational methods in control system design; classical calculus of variations, dynamic programming, maximum principle; optimal digital control systems; state estimation. Prerequisite: E E 527.
530. **ADAPTIVE AND LEARNING SYSTEMS (3)** Adaptive and learning control systems; system identification; performance indices; gradient, stochastic approximation, controlled random search methods; introduction to pattern recognition. Prerequisite: E E 527.
535. **BOUNDARY VALUE METHODS OF ELECTROMAGNETICS (3)** Theory and application of boundary value problems in engineering electromagnetics; topics include microwave and optical waveguides, radiation, and scattering. Prerequisites: E E 411, 432, 438.
536. **INVERSION TECHNIQUES IN REMOTE SENSING (3)** Develop inversion techniques for remotely sensed data. Applications include atmospheric radiative transfer, antenna deconvolution, and microwave spectrometer instrument design. Prerequisites: E E 411, 432, 438, or 439; E E 459.
537. **NUMERICAL AND ASYMPTOTIC METHODS OF ELECTROMAGNETICS (3)** Finite difference in time domain, geometric theory of diffraction and method of moments applied to antennas and scattering.
538. **ANTENNA ENGINEERING (3)** In-depth studies of synthesis methods, aperture sources, broadband antennas, and signal-processing arrays. Prerequisite: E E 438.
539. **MICROWAVE RADAR REMOTE SENSING (3)** Scientific and engineering principles of microwave radar remote sensing of land, sea, and the atmosphere. Prerequisites: E E 411, 438, 439.
540. **(AERSP, NUC E) THEORY OF PLASMA WAVES (3)** Solutions of the Boltzmann equation; waves in bounded an unbounded plasmas; radiation and scattering from plasmas. Prerequisite: E E (AERSP, NUC E) 490.
541. **(NUCE) PLASMA THEORY (3)** Advanced topics in kinetic theory, fluctuation theory, microinstability, and turbulence. Prerequisite: E E (AERSP, NUC E) 490.
545. **SEMICONDUCTOR DEVICE RELIABILITY (3)** Introduction to principles and methods of reliability engineering, application to modern semiconductor component design, and device reliability. Prerequisites: E E 418 or 419; MATH 418.
546. **FIELD-EFFECT DEVICES (3)** The physical background, characteristics, and limitations of surface field-effect and junction field-effect devices and related structures. Prerequisite: E E 419.
547. **DIELECTRIC DEVICES (3)** Applications of insulator physics and devices based on insulator properties. Prerequisite: E E 419.
548. **LINEAR INTEGRATED CIRCUITS (3)** Design of monolithic, thin-film, and hybrid linear integrated circuits; D.C., video, tuned, r.f., and microwave applications. Emphasis on reliability. Prerequisites: E E 418, 448.
550. **NETWORK SYNTHESIS (3)** Positive real functions, reliability conditions, synthesis of driving point immittances, synthesis of two-terminal pair networks, transfer function synthesis. Prerequisite: E E 450.
553. **TOPICS IN DIGITAL SIGNAL PROCESSING (3)** Parametric modeling, spectral estimation, efficient transforms and convolution algorithms, multirate processing, and selected applications involving nonlinear and time-variant filters. Prerequisite: E E 453.
554. **(CSE) ERROR CORRECTING CODES FOR COMPUTERS AND COMMUNICATION (3)** Block, cyclic, and convolutional codes; circuits and algorithms for decoding; application to reliable communication and fault-tolerant computing. Prerequisite: CSE 458.
556. **GRAPHS, ALGORITHMS, AND NEURAL NETWORKS (3)** Examine neural networks by exploiting graph theory for offering alternate solutions to classical problems in signal processing and control.
557. **MULTIDIMENSIONAL SIGNAL PROCESSING (3)** Multidimensional sampling, weak causality, recursibility, multidimensional transforms, stability, global and local state-space models, multidimensional filters, and multidimensional spectrum estimation. Prerequisite: E E 453.
559. **(M E) NONLINEAR CONTROL AND STABILITY (3)** Design of nonlinear automatic control systems; phase-plane methods; describing functions; optimum switched systems; Liapunov stability; special topics in stability. Prerequisite: E E 417, 428, or M E 455.
560. **STOCHASTIC PROCESSES AND ESTIMATION (3)** Review of probability theory and random variables; mathematical description of random signals; linear system response; Wiener, Kalman, and other filtering. Prerequisites: E E 459 or MATH 409.
561. **INFORMATION THEORY (3)** Mathematical measurement of information; information transfer in discrete systems; redundancy, efficiency, and channel capacity; encoding systems. Prerequisite: E E 459 or MATH 409.

562. DETECTION THEORY (3) Detection decision theory, Bayes and Neyman-Pearson criteria, optimal receivers, classical estimation theory, signal-noise representations, optimum linear signal parameters estimation. Prerequisite: E E 560.

563. SIGNAL THEORY I (3) Requires familiarity with fundamentals of linear system theory and rudiments of Fourier analysis. Prerequisites: E E 352, 417.

565. COMPUTER ANALYSIS OF POWER SYSTEMS (3) Network matrix methods of power system analysis. Formulation and computer solution of short circuit, load flow, and transient stability problems. Prerequisite: E E 425 or 461.

566. (M E) ROBUST CONTROL THEORY (3) Fundamentals of Robust Control Theory with emphasis on stability, performance analysis, and design. Prerequisite: E E 527 or M E 555.

569. SIMULATION OF BIOMEDICAL SYSTEMS (3) Simulation of biological and medical systems on analog and digital computers; direct electrical analogs; modeling techniques. Prerequisites: BIOL 101, CMPEN 470.

580. RADIO WAVES AND THE IONOSPHERE (3) The magneto-ionic theory of ionospheric wave propagation; ray-optical approximations; determination of ionization profiles; full wave solutions; nonlinear and coupling effects. Prerequisite: E E 438 or PHYS 557.

581. CONSTITUTION OF THE IONOSPHERE (3) Properties of neutral and ionized atmosphere above 60 km; photochemical processes; solar, meteoric perturbations of the ionosphere; large-scale movements in ionization.

585. (CSE) DIGITAL IMAGE PROCESSING II (3) Advanced treatment of image processing techniques; image restoration, image segmentation, texture, and mathematical morphology. Prerequisite: CSE 485 or E E 485.

586. (CSE) TOPICS IN COMPUTER VISION (3) Discussion of recent advances and current research trends in computer vision theory, algorithms, and their applications. Prerequisite: CSE 486 or E E 486.

590. COLLOQUIUM (1-3)

594. RESEARCH PROJECTS (1-3) Supervision of individual research projects leading to M.S. or M.Eng. papers. Written and oral reports are required.

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

ELECTRICAL ENGINEERING (E E)

ALI BEHAGI, *Program Coordinator*

Penn State Harrisburg

W-252 Olmsted Building; 717-948-6379

Degree Conferred: M.Eng.

The Graduate Faculty

Omid Ansary, Ph.D. (Akron) *Associate Professor of Engineering*

Ali Behagi, Ph.D. (Southern California) *Associate Professor of Engineering*

Peter Idowu, Ph.D. (Toledo) *Assistant Professor of Electrical Engineering*

Jerry F. Shoup, Ph.D. (Penn State) *Associate Professor of Engineering*

Seth Wolpert, Ph.D. (Rutgers) *Assistant Professor of Electrical and Computer Engineering*

Admission

Penn State Harrisburg has an engineering graduate degree program coordinator who examines a candidate's application material and makes recommendations regarding admission.

Application credentials: A complete application for admission will include transcripts, GRE scores (preferable but not required), letters of reference, especially those from faculty who can evaluate academic potential, and a personal statement of technical interest, goals, and experience. An international student whose first language is not English should submit an acceptable TOEFL score (minimum 550).

Admission requirements: A prospective graduate student in Electrical Engineering at Penn State Harrisburg must fulfill the admission requirements as set forth by the Graduate School, and have a bachelor of science degree in electrical engineering or its equivalent. An undergraduate cumulative grade-point average of 3.0 or better on a 4.0 scale is required for admission. Exceptions to this will be based on professional experience and other factors such as GRE scores. Those applying for admission as a master

of engineering candidate without an electrical engineering degree may be admitted with the stipulation that deficiencies in background, if any, will be remedied early in the program and that these courses will be in addition to the required number of credits for the degree.

A student with a 3.0 junior/senior grade-point average and the appropriate course background will be considered for admission as a degree candidate. Students having less than a 3.0 GPA will be admitted a special nondegree students until they have satisfactorily demonstrated their ability to do graduate work. Up to 15 credits earned in three semesters or fewer, as a special nondegree student, may be applied toward the master's degree.

Plan of Study

As soon as possible after admission, a tentative plan of study that will include all courses that are deemed desirable before completion of the master of engineering program should be developed. This plan will be prepared with the help of an adviser and may include specific courses necessary to remove any background deficiencies.

Master of Engineering Paper

A candidate for the master of engineering degree in Electrical Engineering must write a scholarly report or engineering paper and defend it before three faculty members. The paper is intended to be a relatively short document compared with a thesis. A published paper may be used to meet this requirement. The paper should be written according to the standards set for an IEEE publication.

The engineering paper may be initiated by taking the 1-credit ENGR 594 course. This should be done approximately halfway through the program. Once the proposal is approved and the work well under way, the student should register for ENGR 594 with his/her paper adviser. Work will proceed as planned under the direction of the paper adviser, though changes may be made with the consent of the program coordinator and paper adviser.

Degree Requirements

A total of 33 credits is required for a Master of Engineering degree, of which at least 20 must be taken through Penn State Harrisburg engineering graduate programs. Up to 10 credits of graduate work may be transferred from other institutions provided (a) credits are suitable for three particular engineering discipline, and (b) students have earned a grade of B or better. At least 18 credits must be at the 500 level, which includes 3 credits of ENGR 594.

Generally, students enrolled in the program for the Master of Engineering degree in Electrical Engineering must earn 12 credits in the required core courses (i.e., courses with the E E prefix).

ENERGY, ENVIRONMENTAL, AND MINERAL ECONOMICS (ECEEM))

ADAM Z. ROSE, *Department Head*
221 Walker Building
814-865-2549

Degrees Conferred: Ph.D., M.S.

The Graduate Faculty

Timothy J. Considine, Ph.D. (Cornell) *Associate Professor of Energy, Environmental, and Mineral Economics*

Richard L. Gordon, Ph.D. (MIT) *Professor Emeritus of Mineral Economics and MICASU University Endowed Fellow*

Andrew N. Kleit, Ph.D. (Yale) *Associate Professor of Energy, Environmental, and Mineral Economics*

Ahmet E. Kocagil, Ph.D. (CUNY) *Assistant Professor of Energy, Environmental, and Mineral Economics*

Katherine McClain, Ph.D. (California, San Diego) *Assistant Professor of Energy, Environmental, and Mineral Economics*

Adam Z. Rose, Ph.D. (Cornell) *Professor of Energy, Environmental, and Mineral Economics*

George H. K. Schenck, Ph.D. (Penn State) *Associate Professor Emeritus of Mineral Economics*

William A. Vogely, Ph.D. (Princeton) *Professor Emeritus of Mineral Economics*

Zili Yang, Ph.D. (Yale) *Assistant Professor of Energy, Environmental, and Mineral Economics*

Robert U. Ayres, Ph.D. (U of London) *Adjunct Professor of Energy, Environmental, and Mineral Economics*

R. Scott Farrow, Ph.D. (Washington State) *Adjunct Professor of Energy, Environmental, and Mineral Economics*

Hendrik Folmer, Ph.D. (U of Groningen) *Adjunct Professor of Energy, Environmental, and Mineral Economics*

The program, which until spring 1997 was called Mineral Economics, helps students to apply economic analysis to energy, environmental, and mineral problems, particularly those relevant to long-term development. Students may work in such areas as nonrenewable resource and environmental economics (policy, area studies, or global change); commodity market analysis (energy, minerals, or materials); energy economics (conventional and alternative fuels, regulation, or economy and environmental interactions); business economics (management, market research, or finance); or operations research and econometrics (resource allocation, decision theory, forecasting, or model building).

Enrollment is kept at levels that ensure that students work closely on their research with the faculty and can interact regularly with each other. M.S. training leads to employment opportunities in consulting firms; government agencies; environmental affairs; and businesses concerned with the extraction, processing, or use of materials broadly defined. The Ph.D. program is oriented toward research careers in universities, government, and industry.

Admission Requirements

Scores from the Graduate Record Examination (GRE) or the Graduate Management Admission test (GMAT) are required for admission. Requirements listed here in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*. Applicants are encouraged to complete their files (including test scores) by February 15 to receive maximum consideration for financial aid.

The program is designed to accommodate students with either a science and engineering or a social science background. Separate admissions requirements are maintained for the two groups. Requirements for admission for those with science or engineering backgrounds are 24 credits in chemistry, physics, mathematics, or statistics; 12 in the earth sciences; 9 in economics, mineral or environmental economics, commerce, business administration, or industrial management; and 6 in engineering subjects. Those with social science backgrounds should have 12 credits in economics, mineral or environmental economics, or business administration; 6 in earth sciences; and 9 in mathematics and statistics. However, at the discretion of the program, a student may be admitted provisionally without all of these requirements.

Students with deficiencies of 9 credits or fewer in either program may be admitted as degree candidates but will be required to make up such deficiencies without these credits being applicable toward the advanced degree. Admission to the Master's program is largely determined on the basis of achievement of a junior/senior grade point average of 3.00 or better (on a 4.00 scale), above-average scores on the GRE or GMAT, and appropriate prior course work. Students meeting these requirements will be admitted so long as space is available. A prior master's degree is not required for admission to the Ph.D. program. Admission to the Ph.D. program requires a 3.50 or better in the applicant's prior degree program, strong GRE or GMAT scores, and previous course preparation.

Degree Requirements

The core courses in energy, environmental, and mineral economics, economics, statistics, and other related fields are similar for all graduate students. At the M.S. level, the core courses constitute almost the entire program, and students without sufficient prior work find that they must earn 35 to 40 credits to meet these requirements. In addition to the normal degree requirements of the Graduate School, candidates for the M.S. degree must write a thesis or professional paper and defend it orally. M.S. students are required to take 9 to 12 credits in statistics and computer science either before admission or as courses taken in addition to the minimum required for the M.S. degree.

The Ph.D. program offers opportunities for students to extend work in either the technical or economic area. For students who have a master's degree in a related area, prior graduate work is considered to fulfill the requirement for work in related fields, and further work consists mainly of satisfying specific course requirements. Doctoral candidates must complete at least 15 credits in economics (including courses used for admission).

The candidacy examination for the doctorate is oral. The oral examination for the M.S. degree at Penn State may be used as the candidacy examination for the doctorate. If that is done, the M.S. examination is more detailed and broader in scope than it would be for the M.S. alone. The comprehensive examination for the doctorate includes written examinations in the core program and special fields in addition to the oral examination required by the Graduate School. The communication requirement is satisfied by departmentally approved courses in statistics and mathematics. There is no foreign language requirement.

Other Relevant Information

Students in this program may elect the dual-title program in Operations Research for the Ph.D. and M.S. degrees. (*See also* Operations Research.)

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

ENERGY, ENVIRONMENTAL, AND MINERAL ECONOMICS (ECEEM)

482. ECONOMIC ANALYSIS OF MINERALS IN THE ENVIRONMENT (3)

483. MATERIALS POLICY AND MARKETS (3)

484W. POLITICAL ECONOMY OF ENERGY AND THE ENVIRONMENT (3)

490. MINERAL VALUATION AND FINANCIAL TECHNIQUES (3)

491. MINERAL POLICY ANALYSIS (3)

492. ECONOMETRIC APPLICATIONS TO MINERAL MARKETS (3)

495. INTERNSHIP (1–18)

496. INDEPENDENT STUDIES (1–18)

497. SPECIAL TOPICS (1–9)

499. FOREIGN STUDY—MINERAL INDUSTRIES (1–12)

500. ECONOMICS OF ENERGY AND MATERIALS (3) This course introduces students to rigorous economic analysis of policy and planning issues in mineral resource economics. Prerequisite: ECON 302.

501. ECONOMICS OF MINERALS AND ENVIRONMENT (3) Advanced principles of welfare economics, cost-benefit analysis, and nonrenewable resource exhaustion with applications to mining and energy use. Prerequisite: ECEEM 500 or ECON 502.

520. ECONOMETRIC ANALYSIS OF NATURAL RESOURCES (3) Applies econometric analysis to contemporary planning and policy issues facing energy and materials industries. Prerequisites: ECON 501, 502.

530. MINERAL COMMODITY PRICES (3) Discussion of advanced models in natural resource economics. Prerequisites: ECEEM 520, ECON 501, 502.

531. APPLIED GENERAL EQUILIBRIUM ANALYSIS OF MINERAL DEVELOPMENT (3) Analysis of the role of natural resources in international trade and economic development by use of applied general equilibrium models (CGE, SAM, I-O). Prerequisite: approval of department.

540. ECONOMIC ANALYSIS OF ENERGY MARKETS (3) This course uses economic analysis to explain the history of world energy and its regulation since 1945. Prerequisite: ECON 502.

541. ECONOMICS OF ENERGY AND THE ENVIRONMENT (3) Economic analysis of topics such as global warming, alternative energy sources and new technologies, and resources and sustainable development. Prerequisite: approval of department.

542. (GEOSC 510) GEOLOGY AND ECONOMICS OF THE INDUSTRIAL MINERALS (3) Occurrence, origin, and marketing of the industrial minerals and evaluation of deposits. Chemical and ceramic raw materials emphasized.

550. ENVIRONMENTAL ECONOMICS: THEORY AND POLICY (3) Theories and applied methods used in the economic analysis of resource and environmental issues. Prerequisites: ECEEM 500, 501, ECON 502.

551. ENVIRONMENTAL ECONOMICS: APPLICATION/METHODS (3) Introduction to methods for measuring environmental and natural resource values, including hedonic methods, travel cost, random utility models, and contingent valuation. Prerequisite: AG EC 519.

560. MINERAL AND ENERGY FINANCE I (3) Introduction to theory of finance and application of financial tools to commodity market analysis. Emphasis on mineral and energy markets. Prerequisite: approval of the department.

561. THEORY AND METHODS IN MINERAL AND ENERGY FINANCE (3) Theory and contemporary methods in mineral and energy finance; particular emphasis is on project evaluation, financing, and risk management in metals and energy markets. Prerequisite: ECEEM 560.

585. SEMINAR IN ENERGY, ENVIRONMENTAL, AND MINERAL ECONOMICS (1–3) Research presented by faculty, visiting scholars, industry leaders, and students.

ENGINEERING MECHANICS (E MCH)

R. P. McNITT, *Head of the Department of Engineering Science and Mechanics*
227 Hammond Building
814-865-4523

Degrees Conferred: Ph.D. in Engineering Science and Mechanics, M.S., M.Eng.

The Graduate Faculty

Maurice F. Amateau, Ph.D. (Case Western Reserve) *Professor of Engineering Science and Mechanics*
S. Ashok, Ph.D. (Rensselaer) *Professor of Engineering Science*
Ossama O. Awadelkarim, Ph.D. (Reading, England) *Associate Professor of Engineering Science and Mechanics*
Charles E. Bakis, Ph.D. (Virginia Polytechnic) *Assistant Professor of Engineering Science and Mechanics*
R. Bhagat, Ph.D. (Indian Inst. of Tech.) *Senior Research Associate and Associate Professor of Engineering Mechanics*
Courtney B. Burroughs, Ph.D. (Catholic) *Research Associate*
J. C. Conway, Ph.D. (Penn State) *Professor of Engineering Mechanics*
Francesco Costanzo, Ph.D. (Texas A&M) *Assistant Professor of Engineering Science and Mechanics*
Joseph P. Cusumano, Ph.D. (Cornell) *Associate Professor of Engineering Science and Mechanics*
Renata S. Engel, Ph.D. (South Florida) *Associate Professor of Engineering Graphics and Engineering Science and Mechanics*
Stephen J. Fonash, Ph.D. (Pennsylvania) *Distinguished Professor of Engineering Sciences*
R. M. German, Ph.D. (California, Davis) *Professor, Brush Chair in Materials*
Gary L. Gray, Ph.D. (Wisconsin—Madison) *Assistant Professor of Engineering Science and Mechanics*
S. I. Hayek, Dr.Eng.Sci. (Columbia) *Distinguished Professor of Engineering Mechanics*
L. Raymond Hetche, Ph.D. (Carnegie Mellon) *Professor of Engineering Research*
Jaan Kiusalaas, Ph.D. (Northwestern) *Professor Emeritus of Engineering Mechanics*
Akhlesh Lakhtakia, Ph.D. (Utah) *Associate Professor of Engineering Science and Mechanics*
Byung-Lip (Les) Lee, Ph.D. (MIT) *Associate Professor of Engineering Science and Mechanics*
Clifford J. Lissenden, Ph.D. (Virginia) *Assistant Professor of Engineering Science and Mechanics*
P. M. Lenahan, Ph.D. (Illinois) *Professor of Engineering Science and Mechanics*
Herbert H. Lipowsky, Ph.D. (California, San Diego) *Professor of Bioengineering*
R. P. McNitt, Ph.D. (Purdue) *Professor of Engineering Science and Mechanics*
R. F. Messier, Ph.D. (Penn State) *Professor of Engineering Science and Mechanics*
Vernon Neubert, Dr.Engr. (Yale) *Professor Emeritus of Engineering Mechanics*
R. N. Pangborn, Ph.D. (Rutgers) *Professor of Engineering Mechanics*
Andrew Pytel, Ph.D. (Penn State) *Professor Emeritus of Engineering Mechanics*
Jean Landa Pytel, Ph.D. (Penn State) *Assistant Professor of Engineering Mechanics*
R. A. Queeney, Ph.D. (Penn State) *Professor of Engineering Mechanics*
J. L. Rose, Ph.D. (Drexel) *Paul Morrow Professor of Engineering Science and Mechanics in Design and Manufacturing*
Clayton O. Ruud, Ph.D. (Denver) *Professor of Industrial Engineering*
N. J. Salamon, Ph.D. (Northwestern) *Professor of Engineering Mechanics*
Albert E. Segall, Ph.D. (Penn State) *Senior Research Associate and Assistant Professor of Engineering Science and Mechanics*
M. G. Sharma, Ph.D. (Penn State) *Professor Emeritus of Engineering Mechanics*
Barbara A. Shaw, Ph.D. (Johns Hopkins) *Associate Professor of Engineering Science and Mechanics*
William Thompson, Jr., Ph.D. (Penn State) *Professor of Engineering Science*
Bernhard R. Tittmann, Ph.D. (UCLA) *Kunkle Professor of Engineering Science and Mechanics*
M. Urquidi-Macdonald, Ph.D. (U. of Paris, Sud) *Associate Professor of Engineering Science and Mechanics*
Vasundara V. Varadan, Ph.D. (Illinois) *Distinguished Alumni Professor of Engineering Science and Mechanics and Electrical Engineering*
Vijay K. Varadan, Ph.D. (Northwestern) *Distinguished Alumni Professor of Engineering Science and Mechanics and Electrical Engineering*
Christopher R. Wronski, Ph.D. (Imperial College, London) *Leonhard Professor of Microelectronic Materials and Devices*
S. Y. Zamrik, Ph.D. (Penn State) *Professor of Engineering Mechanics*

Graduate programs in Engineering Mechanics emphasize fundamental knowledge and include research opportunities in theoretical and experimental mechanics, with a primary focus on the mechanics and physics of solids.

Graduate study is available in continuum mechanics, structural mechanics, dynamics, vibrations and acoustics, biomechanics, micromechanics, experimental mechanics, and characterization and utilization of materials. Thesis work in these areas is frequently directed toward specific applications of technological interest in biosystems, geosystems, energy production and distribution, materials engineering, and structural design.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are not required for students holding baccalaureate degrees in engineering from accredited U.S. educational institutions. At the discretion of a graduate program, students may be admitted provisionally for graduate study in the program without these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

The entering student must hold a bachelor's degree in engineering or science and have satisfactorily completed undergraduate courses in mechanics. Students with a 2.90 junior/senior average (on a 4.00 scale) and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces available for new students. Exceptions to the minimum grade-point average may be made for students with special backgrounds, abilities, and interests.

Doctoral Degree Requirements

Doctoral candidates must pass a candidacy examination, satisfy a communications requirement, and pass a comprehensive examination.

Programs leading to a minor in Engineering Mechanics are available for doctoral students who seek to complement their studies in their major fields by acquiring a broader background in theoretical and experimental mechanics.

Other Relevant Information

Continuous registration is required for all students until the thesis or engineering report is approved.

Other course offerings of the department are listed under OTHER COURSES CARRYING GRADUATE CREDIT.

Student Aid

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AID section of the *Graduate Bulletin*, the following awards typically have been available to graduate students in this program:

THEODORE HOLDEN THOMAS, JR., MEMORIAL SCHOLARSHIP—Available to undergraduate or graduate students who display outstanding academic ability and have enrolled in the Department of Engineering Science and Mechanics. Apply to the Department of Engineering Science and Mechanics, 227 Hammond Building. Deadline is February 1.

ENGINEERING MECHANICS (E MCH)

- 400. ADVANCED STRENGTH OF MATERIALS AND DESIGN (3)
- 401. DESIGN AND SYNTHESIS IN VIBRATIONS (3)
- 402. APPLIED AND EXPERIMENTAL STRESS ANALYSIS (3)
- 403. STRENGTH DESIGN IN MATERIALS AND STRUCTURES (4)
- 407. COMPUTER METHODS IN ENGINEERING DESIGN (3)
- 408. ELASTICITY AND ENGINEERING APPLICATIONS (3)
- 409. ADVANCED MECHANICS (3)
- 412. EXPERIMENTAL METHODS IN VIBRATIONS (3)
- 416H. FAILURE AND FAILURE ANALYSIS OF SOLIDS (3)
- 440. (MATSC) NONDESTRUCTIVE EVALUATION OF FLAWS (3)
- 446. MECHANICS OF VISCOELASTIC MATERIALS (3)
- 461. (M E) APPLIED FINITE ELEMENT ANALYSIS (3)
- 471. ENGINEERING COMPOSITE MATERIALS (3)
- 473. COMPOSITES PROCESSING (3)
- 496. INDEPENDENT STUDIES (1–18)
- 497. SPECIAL TOPICS (1–9)

500. ADVANCED MECHANICS OF MATERIALS (3) Strain energy methods; thin-/thick-walled cylinders; shrink-fit assemblies; rotating discs; thermal stresses; shells and plates; beams on elastic foundations. Prerequisite: E MCH 013.

506. EXPERIMENTAL STRESS ANALYSIS (3) Experimental methods of stress determination, including photoelasticity, stress coat, and electric strain gauge techniques; stress analogies; strain rosettes for combined stress determinations. Prerequisite: E MCH 408 or 507.

507. THEORY OF ELASTICITY AND APPLICATIONS (3) Equations of equilibrium and compatibility; stresses and strains in beams, curved members, rotating discs, thick cylinders, torsion and structural members. Prerequisite: E MCH 013.

509. THEORY OF PLATES AND SHELLS (3) Bending and buckling of plates; elastic foundations; deformation of shells, multilayer shells, stress and stability analysis, weight optimization, application problems. Prerequisite: E MCH 013.

514. (E SC) ENGINEERING SCIENCE AND MECHANICS SEMINAR (1 per semester) Current literature and special problems in engineering mechanics.

516. MATHEMATICAL THEORY OF ELASTICITY (3) Fundamental equations and problems of elasticity theory; uniqueness theorems and variational principles; methods of stress functions and displacement potential; applications. Prerequisite: E MCH 540.

520. ADVANCED DYNAMICS (3) Dynamics of a particle and of rigid bodies; Newtonian equations in moving coordinate systems; Lagrange's and Hamilton's equations of motion; special problems in vibrations and dynamics. Prerequisites: E MCH 012, MATH 251.

521. (ACS) STRESS WAVES IN SOLIDS (3) Recent advances in Ultrasonic Nondestructive Evaluation; waves; reflection and refraction; horizontal shear; multilayer structure; stress; viscoelastic media; testing principles. Prerequisites: E MCH 524A and 524B.

523. ULTRASONIC NONDESTRUCTIVE EVALUATION (3) Methods, techniques, applications of Ultrasonic Nondestructive Evaluation wave propagation; signal processing and pattern recognition applied to UNDE; practical laboratory demonstrations.

524. MATHEMATICAL METHODS IN ENGINEERING (3 per unit)

Unit A (3) Special functions, boundary value problems, eigenfunctions and eigenvalue problems; applications to engineering systems in mechanics, vibrations, and other fields. Prerequisite: MATH 250 or 251.

Unit B (3) Boundary-value problems in curvilinear coordinates, integral transforms; application to diffusion, vibration, Laplac and Helmholtz equations in engineering systems. Prerequisites: E MCH 524A, E SC 404, or MATH 411.

Unit C (3) Green's functions applied to problems in potentials, vibration, wave propagation and diffusion with special emphasis on asymptotic methods. Prerequisites: E MCH 524B, E SC 406H, or MATH 412.

525. STRUCTURAL VIBRATION AND RADIATION (3) Vibration response, propagation, transmission, and reflection in elastic structures; internal and external damping; fluid loading; impedance discontinuities; acoustic radiation. Prerequisite: ACS 510 or E MCH 522. Concurrent: E MCH 524B.

527. STRUCTURAL DYNAMICS (3) Dynamic behavior of structural systems; normal modes; input spectra; finite element representation of frameworks, plates, and shells; impedance; elastic-plastic response. Prerequisite: E MCH 401 or 522.

528. EXPERIMENTAL METHODS IN VIBRATIONS (3) Investigation of one or more degrees of freedom, free and forced mechanical vibrations, vibration properties of materials, nondestructive testing. Prerequisite: E MCH 401 or 522.

530. MECHANICAL BEHAVIOR OF MATERIALS (3) Engineering materials mechanical responses; stress/strain in service context of temperature, time, chemical environment; mechanical testing characterization; design applications.

531. THEORY OF PLASTICITY AND APPLICATIONS (3) Yield condition; plastic stress-strain relations; theory of slip-line fields; applications to bending, torsion, axially symmetric bodies, metal processing. Prerequisite: E MCH 507.

532. FRACTURE MECHANICS (3) Stress analysis of cracks; stable and unstable crack growth in structures and materials; materials fracture resistance. Prerequisite: E MCH 500.

534. (METAL) MICROMECHANISMS OF FRACTURE (3) Mechanisms of fracture and their relationship to loading conditions, environment, flow behavior, processing history, and microstructure. Prerequisites: E SC 414M, METAL 406.

535. (METAL) CRYSTAL DEFECTS AND DEFORMATION (3) Deformation of crystalline solids containing defects; elastic and plastic responses over a range of temperatures and strain rates. Prerequisite: E SC 414M or METAL 406.

540. INTRODUCTION TO CONTINUUM MECHANICS (3) Algebra and analysis of tensors; balance equations of classical physics; the linear theories of continuum mechanics.

546. THEORY OF VISCOELASTICITY AND APPLICATIONS (3) Linear and nonlinear viscoelastic theories; generalized isotropic & anisotropic viscoelastic stress-strain relations. Prerequisite: E MCH 507.
550. VARIATIONAL AND ENERGY METHODS IN ENGINEERING (3) Application of variational calculus and Hamilton's principle to various conservative and nonconservative systems; closed form and approximate technique. Prerequisite: MATH 251.
552. (BIOE, I E) MECHANICS OF THE MUSCULOSKELETAL SYSTEM (3) Structure and biomechanics of bone, cartilage, and skeletal muscle; dynamics and control of musculoskeletal system models. Prerequisite: consent of program. Prerequisite or concurrent: BIOL 472.
560. FINITE ELEMENT ANALYSIS (3) General theory; application to statics and dynamics of solids, structure, fluids, and heat flow; use of existing computer codes. Prerequisites: CMPSC 201, E MCH 013.
562. (AG E) BOUNDARY ELEMENT ANALYSIS (3) Numerical solution of boundary value problems using fundamental solutions; application to problems in potential theory, diffusion, and elastostatics. Prerequisite: AG E 513, E MCH 461, or E MCH 560.
563. (M E) NONLINEAR FINITE ELEMENTS (3) Advanced theory of semidiscrete formulations for continua and structures; emphasizes dynamic and nonlinear problems. Prerequisite: AG E 513, E MCH 461, or E MCH 560.
570. RANDOM VIBRATIONS IN STRUCTURAL MECHANICS (3) Probability theory applied to random vibrations of linear and nonlinear systems; excitation by ground motion, turbulence, and noise; acoustic damping. Prerequisite: AERSP 411 or E MCH 401 or E MCH 522.
581. MICROMECHANICS OF COMPOSITES (3) A rigorous application of mechanics to the understanding of relationships between microstructure and thermomechanical properties of composites. Prerequisite: CERSC 414, CERSC 502, E MCH 408, E MCH 471, or E MCH 507.
582. METAL MATRIX COMPOSITES (3) Processing and properties of metal matrix composites, with emphasis on fabrication techniques, interfaces, fatigue, fracture, and micromechanics. Prerequisite: E MCH 471.
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

Note: Other departmental courses are listed under Engineering Science.

ENGINEERING SCIENCE (E SC)

JOHN M. MASON, JR., *Associate Dean for Graduate Studies and Research,*
College of Engineering

101 Hammond Building; 814-865-4542

Penn State Great Valley School of Graduate Professional Studies—DAVID W. RUSSELL,
Division Head, Engineering; 610-648-3335

Penn State Harrisburg—WILLIAM A. WELSH, JR., *Coordinator; 717-948-6097*

Degree Conferred: M.Eng.

The Graduate Faculty—Penn State Great Valley

Robert M. Hartman, Ph.D. (Delaware) *Associate Professor of Mechanical Engineering*

Kathryn Jablow, Ph.D. (Ohio State) *Associate Professor of Mechanical Engineering*

Eugene Kozik, Ph.D. (Pittsburgh) *Associate Professor of Industrial Engineering*

John I. McCool, M.S. (Drexel) *Assistant Professor of Industrial Engineering*

David W. Russell, Ph.D. (Manchester) *Associate Professor of Electrical Engineering*

Lily Sehayek, Ph.D. (Rutgers) *Assistant Professor of Environmental Engineering*

James Weisbecker, Ph.D. (Temple) *Assistant Professor of Computer Science*

The Graduate Faculty—Penn State Harrisburg

O. Ansary, Ph.D. (Akron) *Associate Professor of Engineering*

Alex Aswad, Ph.D. (Denver) *Professor of Engineering*

Katherine Baker, Ph.D. (Delaware) *Assistant Professor of Environmental Microbiology*

Ganesh P. Bal, Ph.D. (Virginia Polytechnic) *Assistant Professor of Engineering*

Ali Behagi, Ph.D. (USC) *Associate Professor of Engineering*

Thang N. Bui, Ph.D. (MIT) *Associate Professor of Engineering*

Michael J. Cardamone, Ph.D. (Penn State) *Professor of Physics*

Joseph J. Cecere, Ph.D. (North Texas State) *Associate Professor of Engineering*

Yohchia Chen, Ph.D. (Minnesota) *Associate Professor of Engineering*

ENGINEERING SCIENCE

Charles A. Cole, Ph.D. (Rutgers) *Professor of Engineering*
Jefferson S. Hartzler, Ph.D. (Penn State) *Associate Professor of Mathematics*
R. Scott Huebner, Ph.D. (Penn State) *Assistant Professor of Engineering*
Peter Idowu, Ph.D. (Toledo) *Assistant Professor of Engineering*
Harris Imadojemu, Ph.D. (North Carolina A&T) *Associate Professor of Engineering*
Samuel A. McClintock, Ph.D. (Virginia Polytechnic) *Associate Professor of Engineering*
Seroj Mackertich, Ph.D. (Penn State) *Assistant Professor of Engineering*
Linda M. Null, Ph.D. (Iowa State) *Assistant Professor of Computer Science*
George A. Partridge, Ph.D. (Tennessee) *Assistant Professor of Engineering*
Gautam Ray, Ph.D. (Penn State) *Professor of Engineering*
Winston A. Richards, Ph.D. (Western Ontario) *Associate Professor of Mathematics*
M. Susan Richman, Ph.D. (Aberdeen) *Associate Professor of Mathematics*
Jerry F. Shoup, Ph.D. (Penn State) *Associate Professor of Engineering*
Clifford H. Wagner, Ph.D. (SUNY, Albany) *Associate Professor of Mathematics*
Timothy A. Wahls, Ph.D. (Iowa State) *Assistant Professor of Computer Science*
William A. Welsh, Jr., Ph.D. (Illinois) *Associate Professor of Engineering*
Seth Wolpert, Ph.D. (Rutgers) *Assistant Professor of Engineering*
Yuefeng Xie, Ph.D. (Tsinghua) *Assistant Professor of Environmental Engineering*

A program leading to the degree of Master of Engineering with a major in Engineering Science is offered at Penn State Great Valley and Penn State Harrisburg. The program is designed to provide a broad, advanced education in the engineering sciences with some specialization permitted in the area of the student's major interest. It is offered specifically to permit practicing engineers to pursue advanced studies through evening classes while in full-time employment in industry in the area. Courses offered for the program are all established and authorized by the resident departments at the University Park campus.

Admission Requirements

Scores from the graduate Record Examination (GRE) are not required for students holding baccalaureate degrees from accredited U.S. educational institutions. At the discretion of a graduate program, students may be admitted for graduate study in a program without these scores. Requirements listed here are in addition to general Graduate School requirements state in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Students may be admitted to the program from a wide variety of disciplines. Students applying for admission are expected to have completed the following core courses: (1) physics through modern physics; (2) mathematics through differential equations; (3) one course in engineering thermodynamics; (4) one course in electrical circuits; and (5) basic courses in engineering statics and dynamics. Students with a 2.50 junior/senior grade-point average (on a 4.00 scale) and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

Degree Requirements

The credit requirements in this major will be satisfied by an appropriate combination of core courses and elective courses. The core courses include offerings in mathematics and in several branches of engineering that have been selected because of their general character and breadth of applicability to all fields of engineering.

A minimum of 30 credits is required, of which at least 12 must be at the 500 level. A scholarly written report is also required. Three of the above credits may be applied to this report.

This program should be distinguished from the graduate program in Engineering Science at University Park campus, which offers the M.S. degree.

Other Relevant Information

More details regarding admission requirements are available from the directors of the graduate centers offering the program.

Student Aid

Fellowships, traineeships, graduate assistantships, and other forms of financial aid are described in the STUDENT AID section of the *Graduate Bulletin*.

ENGINEERING SCIENCE (E SC)

R. P. McNITT, *Head of the Department of Engineering Science and Mechanics*
227 Hammond Building
814-865-4523

Degrees Conferred: Ph.D. in Engineering Science and Mechanics, M.S.

The Graduate Faculty

Maurice F. Amateau, Ph.D. (Case Western Reserve) *Professor of Engineering Science and Mechanics*
S. Ashok, Ph.D. (Rensselaer) *Professor of Engineering Science*
Osama O. Awadelkarim, Ph.D. (Reading, England) *Associate Professor of Engineering Science and Mechanics*
Charles E. Bakis, Ph.D. (Virginia Polytechnic) *Associate Professor of Engineering Science and Mechanics*
R. Bhagat, Ph.D. (Indian Inst of Tech.) *Senior Research Associate and Associate Professor of Engineering Mechanics*
Courtney B. Burroughs, Ph.D. (Catholic) *Research Associate*
J. C. Conway, Ph.D. (Penn State) *Professor of Engineering Mechanics*
Francesco Costanzo, Ph.D. (Texas A&M) *Assistant Professor of Engineering Science and Mechanics*
Joseph P. Cusumano, Ph.D. (Cornell) *Associate Professor of Engineering Science and Mechanics*
D. C. Davis, Ph.D. (Rensselaer) *Associate Professor of Engineering Science and Mechanics*
Renata S. Engel, Ph.D. (South Florida) *Associate Professor of Engineering Graphics and Engineering Science and Mechanics*
Stephen J. Fonash, Ph.D. (Pennsylvania) *Distinguished Professor of Engineering Sciences*
Eliot Fried, Ph.D. (Cal.Tech.) *Assistant Professor of Engineering Science and Mechanics*
R. M. German, Ph.D. (California, Davis) *Professor, Brush Chair in Materials*
Gary L. Gray, Ph.D. (Wisconsin, Madison) *Assistant Professor of Engineering Science and Mechanics*
S. I. Hayek, Dr. Eng. Sci. (Columbia) *Distinguished Professor of Engineering Mechanics*
L. Raymond Hettche, Ph.D. (Carnegie-Mellon) *Professor of Engineering Research*
Jaan Kiusalaas, Ph.D. (Northwestern) *Professor Emeritus of Engineering Mechanics*
Saluru Krupanidhi, Ph.D. (Delhi University) *Associate Professor of Engineering Science and Mechanics*
Akhlesh Lakhtakia, Ph.D. (Utah) *Associate Professor of Engineering Science and Mechanics*
Byung-Lip (Les) Lee, Ph.D. (MIT) *Associate Professor of Engineering Science and Mechanics*
P. M. Lenahan, Ph.D. (Illinois) *Professor of Engineering Science and Mechanics*
Herbert H. Lipowsky, Ph.D. (California, San Diego) *Professor of Bioengineering*
Clifford J. Lissenden, Ph.D. (Virginia) *Assistant Professor of Engineering Science and Mechanics*
R. P. McNitt, Ph.D. (Purdue) *Professor of Engineering Science and Mechanics*
R. Messier, Ph.D. (Penn State) *Professor of Engineering Science and Mechanics*
Vernon Neubert, Dr. Engr. (Yale) *Professor Emeritus of Engineering Mechanics*
R. N. Pangborn, Ph.D. (Rutgers) *Professor of Engineering Mechanics*
Andrew Pytel, Ph.D. (Penn State) *Professor Emeritus of Engineering Mechanics*
Jean Landa Pytel, Ph.D. (Penn State) *Assistant Professor of Engineering Mechanics*
R. A. Queeney, Ph.D. (Penn State) *Professor of Engineering Mechanics*
J. L. Rose, Ph.D. (Drexel) *Paul Morrow Professor of Engineering Science and Mechanics in Design and Manufacturing*
Clayton O. Ruud, Ph.D. (Denver) *Professor of Industrial Engineering*
N. J. Salamon, Ph.D. (Northwestern) *Professor of Engineering Mechanics*
Albert E. Segall, Ph.D. (Penn State) *Senior Research Associate and Assistant Professor of Engineering Science and Mechanics*
M. G. Sharma, Ph.D. (Penn State) *Professor Emeritus of Engineering Mechanics*
Barbara A. Shaw, Ph.D. (Johns Hopkins) *Associate Professor of Engineering Science and Mechanics*
William Thompson, Jr., Ph.D. (Penn State) *Professor of Engineering Science*
Bernhard R. Tittmann, Ph.D. (UCLA) *Kunkle Professor of Engineering Science and Mechanics*
M. Urquidi-Macdonald, Ph.D. (U. of Paris—Sud) *Associate Professor of Engineering Science and Mechanics*
Vasundara V. Varadan, Ph.D. (Illinois) *Distinguished Alumni Professor of Engineering Science and Mechanics and Electrical Engineering*
Vijay K. Varadan, Ph.D. (Northwestern) *Distinguished Alumni Professor of Engineering Science and Mechanics and Electrical Engineering*

Christopher R. Wronski, Ph.D. (Imperial College, London) *Leonhard Professor of Microelectronic Materials and Devices.*

S. Y. Zamrik, Ph.D. (Penn State) *Professor of Engineering Mechanics*

Admission Requirements

Scores from the Graduate Record Examination (GRE) are not required for students holding baccalaureate degrees in engineering from accredited U.S. educational institutions. At the discretion of a graduate program, students may be admitted provisionally for graduate study in the program without these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Admission to the program requires a bachelor's degree in engineering or science from an accredited institution, with a junior/senior grade-point average of at least 2.90. The best-qualified applicants will be accepted up to the number of spaces that are available for new students.

Degree Requirements

The basic requirements of course work by subject area are as follows:

Engineering Analysis—6 credits

Materials—6 credits

Basic Sciences—6 credits

Engineering Sciences—6 credits

Within these guidelines, work in the listed areas may be arranged in consultation with an adviser to constitute a program to accommodate the objectives of the student, and it is expected that courses outside the department may constitute part of the content in the engineering sciences.

Doctoral candidates must pass a candidacy examination, satisfy a communications requirement, and pass a comprehensive examination.

Programs leading to a minor in Engineering Science are available for doctoral students who want to complement their studies in their major fields by acquiring a broader background in theoretical and experimental mechanics.

A thesis is required for the M.S. degree as part of the 30 credits required in the program. Continuous registration is required for all graduate students until the thesis is approved.

Other Relevant Information

This program should be distinguished from the graduate programs in Engineering Science at Penn State Harrisburg, and Penn State Great Valley, which offer the M.Eng. degree.

Student Aid

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AID section of the *Graduate Bulletin*, the following awards typically have been available to graduate students in this program:

THEODORE HOLDEN THOMAS, JR., MEMORIAL SCHOLARSHIP—Available to undergraduate or graduate students who display outstanding academic ability and have enrolled in the Department of Engineering Science and Mechanics. Apply to the Department of Engineering Science and Mechanics, 227 Hammond Building. Deadline is February 1.

ENGINEERING SCIENCE (E SC)

400H. ELECTROMAGNETIC FIELDS (3)

404H. ANALYSIS IN ENGINEERING SCIENCE, HONORS (3)

405H. ENGINEERING APPLICATIONS OF FIELD THEORY, HONORS (3)

406H. ANALYSIS IN ENGINEERING SCIENCE II, HONORS (3)

407H. COMPUTER METHODS IN ENGINEERING SCIENCE, HONORS (3)

410H. SENIOR DESIGN PROJECT, HONORS (3)

411H. SENIOR DESIGN PROJECT, HONORS (4)

414M. ELEMENTS OF MATERIALS SCIENCE (3)

433H. ENGINEERING SCIENCE RESEARCH LABORATORY EXPERIENCE (1)

445. SEMICONDUCTOR OPTOELECTRONIC DEVICES (3)

450. SYNTHESIS AND PROCESSING OF ELECTRONIC AND PHOTONIC MATERIALS (3)

475. PARTICULATE MATERIALS PROCESSING (3)

494. SENIOR THESIS (1–9)

496. INDEPENDENT STUDIES (1–18)

497. SPECIAL TOPICS (1–9)

501. SOLID STATE ENERGY CONVERSION (3) Principles of solid state energy conversion and their utilization in engineering devices. Emphasis on current research and development efforts. Prerequisite: E E 419 or PHYS 412.

502. SEMICONDUCTOR HETEROJUNCTIONS AND APPLICATIONS (3) Theory, fabrication techniques, and electronic applications of semiconductor heterojunctions, including metal-semiconductor and electrolyte-semiconductor junctions. Prerequisite: E SC 314 or 414M.

511. ENGINEERING MATERIALS FOR ENERGY CONVERSION AND STORAGE (3) This course treats engineering materials and systems employed in conventional and unconventional direct energy conversion and energy storage.

514. (E MCH) ENGINEERING SCIENCE AND MECHANICS SEMINAR (1 per semester) Current literature and special problems in engineering science.

536. WAVE PROPAGATION AND SCATTERING (4) Survey of analytical and numerical methods for solving acoustic, electromagnetic, and elastic wave propagation and scattering problems. Prerequisite: E MCH 524A or 524B.

537. MULTIPLE SCATTERING THEORIES AND DYNAMIC PROPERTIES OF COMPOSITE MATERIALS (3) Acoustic, dielectric, elastic dynamic properties; periodic, random composites; wave propagation and scattering; attenuation, dispersion; supersonic absorption; sonar, optical, ultrasonic applications.

577. ENGINEERED THIN FILMS (3) Broad overview of the preparation-characterization-property relations for thin films used in a wide range of industrial applications. Prerequisites: MATH 251, PHYS 237.

581. MICROELECTROMECHANICAL SYSTEMS/SMART STRUCTURES (3) Methods of micromachining, smart structure fabrication. Design, modeling for physical, chemical, and biomedical microsensors/actuators. Smart structures and microsystems packaging/integration. Prerequisite: E SC 414.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

NOTE: Other departmental courses are listed under Engineering Mechanics.

ENGLISH (ENGL)

SUSAN K. HARRIS, *Director of Graduate Studies*

22 Burrowes Building

814-863-3069; Fax: 814-863-7285

Degrees Conferred: Ph.D., M.A., M.F.A., M.Ed.

The Graduate Faculty

Michael Anesko, Ph.D. (Harvard) *Associate Professor of English*

Robin Becker, M.A. (Boston) *Associate Professor of English*

Michael H. Begnal, Ph.D. (Washington) *Professor of English and Comparative Literature*

Bernard W. Bell, Ph.D. (Massachusetts) *Professor of English*

Kevin J. H. Berland, Ph.D. (McMaster) *Associate Professor of English*

Don H. Bialostosky, Ph.D. (Chicago) *Professor of English*

John D. C. Buck, Ph.D. (California, Berkeley) *Assistant Professor of English*

Robert E. Burkholder, Ph.D. (South Carolina) *Associate Professor of English*

Barbara Cantalupo, A.B. (Rochester) *Associate Professor of English*

Charles Cantalupo, Ph.D. (Rutgers) *Professor of English*

Patrick G. Cheney, Ph.D. (Toronto) *Associate Professor of English*

Deborah Clarke, Ph.D. (Yale) *Associate Professor of English*

Christopher Clausen, Ph.D. (Queen's University, Canada) *Professor of English*

William J. Cobb, Ph.D. (Houston) *Assistant Professor of English*

Phyllis B. Cole, Ph.D. (Harvard) *Associate Professor of English*

William G. Crisman, Ph.D. (California, Berkeley) *Associate Professor of English, Comparative Literature, and German*

Mary G. De Jong, Ph.D. (South Carolina) *Associate Professor of English and Women's Studies*

- Richard M. Doyle, Ph.D. (California, Berkeley) *Assistant Professor of English*
 Caroline D. Eckhardt, Ph.D. (Michigan) *Professor of English and Comparative Literature*
 Robert R. Edwards, Ph.D. (California, Riverside) *Professor of English and Comparative Literature*
 William Ellis, Ph.D. (Ohio State) *Associate Professor of English*
 Richard C. Frushell, Ph.D. (Duquesne) *Associate Professor of English and Comparative Literature*
 Robert H. Gannon, *Associate Professor of English*
 Cheryl Glenn, Ph.D. (Ohio State) *Associate Professor of English*
 Stephen R. Grecco, M.F.A. (Yale) *Associate Professor of English*
 Caroline K. B. Hall, Ph.D. (Brown) *Associate Professor of English and American Studies*
 Susan K. Harris, Ph.D. (Cornell) *Professor of English*
 William J. Harris, Ph.D. (Stanford) *Associate Professor of English*
 John T. Harwood, Ph.D. (Nebraska) *Associate Professor of English*
 Charlotte Holmes, M.F.A. (Columbia) *Associate Professor of English*
 Evelyn Hovanec, Ph.D. (Pittsburgh) *Associate Professor of English*
 Kathryn Hume, Ph.D. (Pennsylvania) *Distinguished Professor of English*
 Robert D. Hume, Ph.D. (Pennsylvania) *Evan Pugh Professor of English*
 Caren Ellen Irr, Ph.D. (Duke) *Assistant Professor of English*
 Nicholas A. Joukovsky, D.Phil. (Oxford) *Associate Professor of English*
 Carol Kessler, Ph.D. (Pennsylvania) *Professor of English, American Studies, and Women's Studies*
 Michael Kiernan, Ph.D. (Harvard) *Associate Professor of English*
 Laura L. Knoppers, Ph.D. (Harvard) *Associate Professor of English*
 Richard Kopley, Ph.D. (SUNY) *Associate Professor of English*
 Jeanne E. Krochalis, Ph.D. (Harvard) *Associate Professor of English*
 Claudia Limbert, Ph.D. (Boston) *Associate Professor of English*
 Robert E. Lougy, Ph.D. (California, Davis) *Associate Professor of English*
 Margaret Lyday, Ph.D. (Catholic University of America) *Associate Professor of English*
 Shirley Marchalonis, Ph.D. (Penn State) *Professor Emerita of English and Comparative Literature*
 Ian Marshall, Ph.D. (Delaware) *Associate Professor of English*
 James E. May, Ph.D. (Maryland) *Associate Professor of English*
 William B. McCarthy, Ph.D. (Indiana) *Professor of English*
 Linda Patterson Miller, Ph.D. (Delaware) *Professor of English*
 Dinty Moore, M.F.A. (Louisiana State) *Associate Professor of English*
 John W. Moore, Jr., Ph.D. (Stanford) *Associate Professor of English*
 J. Philip Mosley, Ph.D. (East Anglia) *Associate Professor of English and Comparative Literature*
 Carla J. Mulford, Ph.D. (Delaware) *Associate Professor of English*
 Leonard Mustazza, Ph.D. (SUNY) *Professor of English*
 Jeffrey Nealon, Ph.D. (Loyola) *Associate Professor of English*
 Jon Olson, Ph.D. (USC) *Assistant Professor of Writing*
 Paul Orlov, Ph.D. (Toronto) *Associate Professor of English*
 Iyunolu F. Osagie, Ph.D. (Cornell) *Assistant Professor of English*
 Beverly Peterson, Ph.D. (William and Mary) *Assistant Professor of English*
 R. Alan Price, Ph.D. (Rochester) *Associate Professor of English*
 Steven D. Putzel, Ph.D. (Toronto) *Associate Professor of English*
 James M. Rambeau, Ph.D. (Rutgers) *Associate Professor of English and American Studies*
 Mike Riley, Ph.D. (Ohio) *Associate Professor of English*
 Francesca Royster, Ph.D. (California, Berkeley) *Assistant Professor of English*
 Peter H. Schneeman, Ph.D. (Minnesota) *Associate Professor of English*
 Robin G. Schulze, Ph.D. (Michigan) *Associate Professor of English*
 Sanford Schwartz, Ph.D. (Princeton) *Associate Professor of English*
 Marie J. Secor, Ph.D. (Brown) *Associate Professor of English*
 Robert A. Secor, Ph.D. (Brown) *Professor of English and American Studies*
 John L. Selzer, Ph.D. (Miami) *Professor of English*
 Alice Sheppard, Ph.D. (Cornell) *Assistant Professor of English*
 Gayle L. Smith, Ph.D. (Massachusetts) *Associate Professor of English*
 James F. Smith, Ph.D. (Penn State) *Professor of English*
 Thomas Smith, Ph.D. (Rutgers) *Assistant Professor of English*
 Adam J. Sorkin, Ph.D. (North Carolina) *Professor of English*
 Sandra Spanier, Ph.D. (Penn State) *Associate Professor of English*
 Susan Squier, Ph.D. (Stanford) *Julia Gregg Brill Professor of English and Women's Studies*
 Suzanne Stutman, Ph.D. (Temple) *Professor of English*

Garrett Sullivan, Ph.D. (Brown) *Assistant Professor of English*
 Kenneth A. Thigpen, Ph.D. (Indiana) *Associate Professor of English and Comparative Literature*
 Toby Thompson, M.A. (Virginia) *Associate Professor of English*
 Tramble Turner, Ph.D. (North Carolina) *Associate Professor of English*
 Anthony Vallone, M.F.A. (Indiana) *Associate Professor of English*
 Daniel Walden, Ph.D. (NYU) *Professor Emeritus of American Studies*
 Jeffrey Walker, Ph.D. (California, Berkeley) *Associate Professor of English*
 Evan Watkins, Ph.D. (Iowa) *Professor of English*
 Stanley Weintraub, Ph.D. (Penn State) *Evan Pugh Professor of Arts and Humanities*
 James L. W. West III, Ph.D. (South Carolina) *Distinguished Professor of English*
 Linda Woodbridge, Ph.D. (UCLA) *Professor of English*
 Paul Youngquist, Ph.D. (Virginia) *Associate Professor of English*

Candidates for the M.A. and Ph.D. in English may choose from a variety of courses in literature in the English language, rhetoric and composition, and theory/cultural studies. The M.F.A. in English helps prepare candidates for professional careers as writers of fiction, poetry, or nonfiction. The M.Ed. is offered in cooperation with the College of Education.

The department offers a strong college-level teacher-training program, and most graduate students in English have the opportunity to serve as teaching assistants. Students usually begin by teaching basic composition courses, but there are opportunities for advanced students to teach courses in business writing, technical writing, fiction writing, poetry writing, literature, and humanities, and to serve as tutors in the Writing Center.

Admission Requirements

Requirements listed in this section are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Applicants should have a junior/senior grade-point average of 3.50 (on a 4.00 scale), although exceptions may be made for students with special backgrounds, abilities, and interests. Scores from the Graduate Record Examination (GRE) Aptitude Tests (verbal and quantitative) are required for admission. Applicants must also submit three letters of recommendation.

For admission, M.A. students should have strong backgrounds in English courses: 18 credits beyond freshman composition are a minimum, but the department prefers at least 24 credits. All applicants should submit writing samples indicating their ability to do analytical or original work.

For admission into the M.F.A. program, students must have a baccalaureate degree (with substantial work in English), a portfolio of publishable student writing, and the intention to pursue a career as a professional writer.

To be considered for the doctoral program, students must have completed an M.A. in English or its equivalent. The records of potential students should indicate promise of superior work in doctoral study.

Master's Degree Requirements

M.A. candidates are required to take 30 credits, distributed as follows:

English 501

One course in literary theory or rhetoric

Two courses in literature in English prior to 1800

Two courses in literature in English after 1800

M.A. candidates must also fulfill the language requirement in one foreign language and submit a writing project. A thesis is not required.

M.F.A. candidates are required to take 48 credits, distributed as follows:

15 credits in ENGL 512, 513, or 515, at least 12 of which must be in the student's area of specialization

6–12 credits in ENGL 596 for the final project

6–12 credits in electives (400- and 500-level courses)

15 credits in literature at the 500 level

Candidates will complete an examination within their area of specialization and a final project that will be a book-length manuscript of publishable quality.

M.Ed. candidates take at least 33 credits, 6 of which must be in a field of professional education. There are no foreign language or thesis requirements. All M.Ed. candidates must pass the M.A. examination and submit a final paper to the department.

Doctoral Degree Requirements

The Ph.D. degree does not require a specific number of credits. With the help of departmental graduate advisers, students select a program of small seminars or reading courses. ENGL 501 is required. To complete their programs, students must show reading proficiency in one foreign language, pass written comprehensive examinations, and write and defend a doctoral dissertation.

Student Aid

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AID section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

EDWIN ERLE SPARKS FELLOWSHIPS IN THE HUMANITIES (8)—Available to beginning and continuing graduate students in one of the following graduate programs: Comparative Literature, English, French, German, History, Linguistics, Philosophy, Spanish, and Speech Communication; stipend \$11,560 plus waiver of tuition. Apply to department before February 1.

KATEY LEHMAN FELLOWSHIP—Provides approximately \$13,000 plus tuition for a year's study in poetry or fiction writing leading toward an M.F.A. in English. The Lehman Fellow will teach one course during the fellowship year. Fellowship holders are eligible for graduate assistantships with a similar stipend and tuition grant during the second year of study.

WILMA EBBITT AWARD—Funding to support research in rhetoric. Number and amount of awards to be determined.

BEN EUWEMA MEMORIAL SCHOLARSHIP—Travel funding for graduate degree candidates; consideration will be given to all currently enrolled graduate students in English. Preference will be given to students at the Ph.D. thesis stage, particularly those who need to travel to complete their research; number of awards and amount of each will be determined each year.

FOLGER INSTITUTE FELLOWSHIPS—Penn State is a member of the Folger Institute of Renaissance and Eighteenth-Century Studies. Graduate students in English are eligible for Folger Institute Fellowship to study in seminars and workshops at the Folger Library, Washington, D.C.

PHILIP YOUNG MEMORIAL AWARD—Funding to support research in American Literature. Number and amount of awards will be determined.

ENGLISH (ENGL)

501. MATERIALS AND METHODS OF RESEARCH (3) Materials and techniques of research in English and American literary history; form and content of theses. Required of all graduate students with an English major.

502. THEORY AND TEACHING OF COMPOSITION (3) Study of grammar, logic, rhetoric, and style in their applicability to teaching composition.

503. (LL ED) RESEARCH METHODS IN COMPOSITION (3) Introduction to the issues and methods of empirical research in composition.

504. RHETORIC AND POETICS (3) Historical relations between rhetorical theory and poetics; approaches to rhetorical criticism of poetic discourse.

506. THE ENGLISH LANGUAGE (3) A problem-centered approach to literary and oral forms of English, utilizing historical and analytic perspectives.

508. COMPUTER APPLICATIONS FOR WRITERS AND HUMANITIES SCHOLARS (3) Computer applications for writers and humanities scholars: introduction to terminal-editing, retrieval, bibliographic, and textual analysis systems.

510. SCHOLARLY EDITING: THEORY AND PRACTICE (3) Study of editorial theory from McKerrow and Greg to the present; experience in scholarly editing and manuscript study. Prerequisite: ENGL 501.

512. THE WRITING OF FICTION (3 per semester, maximum of 15) Supervised workshop in advanced techniques of writing fiction.

513. THE WRITING OF POETRY (3 per semester, maximum of 15) For the student with considerable experience in writing poetry; a workshop devoted to advanced poetic technique.

515. THE WRITING OF NONFICTION (3 per semester, maximum of 15) Supervised workshop in advanced nonfiction techniques.

518. BUSINESS AND TECHNICAL WRITING: CURRENT THEORY (3) Intensive examination of

current theories and practice in business and technical communication; written projects exploring specific theories and problems.

521. OLD ENGLISH LANGUAGE (3) An introduction to the main features of the Old English language; readings in simple Old English prose and poetry.

522. BEOWULF (3) Reading and critical analysis. Prerequisite: ENGL 521.

530. LITERATURE OF BIOGRAPHY AND AUTOBIOGRAPHY (3) Study of biographical and autobiographical theory and practice through analysis of major English and American works.

540. STUDIES IN ELIZABETHAN PROSE AND POETRY (1–3 per semester, maximum of 12) Major figures studied will vary from year to year. Writers studied might include figures such as Spenser and Sidney.

541. MEDIEVAL STUDIES (1–3 per semester, maximum of 12) Studies in medieval English literature. Topics studied might include medieval romances, drama, or major figures aside from Chaucer.

542. MIDDLE ENGLISH LITERATURE (3) Introduction to Middle English and its dialects; study of the literature of the period exclusive of Chaucer.

543. STUDIES IN EARLY SEVENTEENTH-CENTURY LITERATURE (1–3 per semester, maximum of 12) Major figures studied will vary from year to year. Writers studied might include Donne, Herbert, Jonson, Bacon.

545. CHAUCER (1–3 per semester, maximum of 12) Major and minor works of Geoffrey Chaucer. The works studied will vary from year to year.

546. MILTON (3) The poetry and prose of John Milton.

548. ELIZABETHAN AND JACOBEAN DRAMA (1–3 per semester, maximum of 12) English drama from 1558 to 1642, exclusive of Shakespeare.

549. SHAKESPEARE (1–3 per semester, maximum of 12) Special problems of sources, chronology, text, characterization, and motivation in the drama.

550. ENGLISH LITERATURE 1660–1800 (1–3 per semester, maximum of 12) Major figures studied will vary from year to year. Writers studied might include Dryden, Swift, Pope, Johnson, Fielding, Gibbon.

551. ENGLISH DRAMA 1660–1800 (1–3 per semester, maximum of 12) Major figures studied will vary from year to year. Writers studied might include Wycherley, Farquhar, Dryden, Congreve, Etherege.

554. STUDIES IN EARLY AMERICAN LITERATURE (1–3 per semester, maximum of 12) Major figures will vary from year to year. Writers studied might include Bradstreet, Taylor, Mather, Franklin, Edwards, Paine.

556. EIGHTEENTH-CENTURY BRITISH FICTION (1–3 per semester, maximum of 12) Major figures studied might include Defoe, Smollet, Fielding, Richardson, Sterne.

558. NINETEENTH-CENTURY BRITISH FICTION (1–3 per semester, maximum of 12) Major figures studied will vary from year to year. Writers studied might include Dickens, Thackeray, the Brontës, George Eliot, Hardy.

559. STUDIES IN TWENTIETH-CENTURY BRITISH FICTION (1–3 per semester, maximum of 12) Major figures studied will vary from year to year. Writers studied might include Conrad, Lawrence, Joyce, Woolf, Green, Fowles, Graham Swift.

560. AMERICAN ROMANTICISM (1–3 per semester, maximum of 12) Major figures studied will vary from year to year. Writers studied might include Hawthorne, Melville, Emerson, Thoreau, Whitman.

561. STUDIES IN THE ROMANTIC MOVEMENT (1–3 per semester, maximum of 12) Major figures studied will vary from year to year. Writers studied might include Blake, Wordsworth, Coleridge, Byron, Shelley, Keats.

562. STUDIES IN THE LITERATURE OF VICTORIAN ENGLAND (1–3 per semester, maximum of 12) Figures will vary from year to year. Writers studied might include Tennyson, Browning, Arnold, Newman, Ruskin, Trollope.

564. STUDIES IN NINETEENTH-CENTURY AMERICAN LITERATURE (1–3 per semester, maximum of 12) Writers will vary from year to year. Writers studied might include Cooper, Poe, Dickinson, Twain, James.

565. PERIOD STUDIES IN AFRICAN-AMERICAN LITERATURE (3 per semester/maximum of 9) Studies of periods in African-American literature. Periods might include the Harlem Renaissance or the Black Arts Movement.

566. GENRE STUDIES IN AFRICAN-AMERICAN LITERATURE (3 per semester/maximum of 9) Genre will vary from year to year, but will include categories such as poetry, fiction, essays, sermons, autobiographies, short stories.

567. THEMATIC STUDIES IN AFRICAN-AMERICAN LITERATURE (3 per semester/maximum of 9) Exploration of key concepts in African-American culture as manifested in various literary discourses.

568. GENDER ISSUES IN AFRICAN-AMERICAN LITERATURE (3 per semester/maximum of 9) Gender issues in African-American literature and culture. Issues may include the Black Woman writer or Gay and Lesbian writers.

573. STUDIES IN TWENTIETH-CENTURY BRITISH LITERATURE (1–3 per semester, maximum of 12) Major figures studied will vary from year to year. Writers studied might include Yeats, Conrad, Joyce, Shaw, Lawrence, Auden.
574. STUDIES IN TWENTIETH-CENTURY AMERICAN LITERATURE (1–3 per semester, maximum of 12) Figures studied will vary from year to year. Writers studied might include Dreiser, Wharton, Eliot, Hemingway, Fitzgerald, Faulkner, O'Neill, Williams.
575. EXPERIMENTALISM AND MODERNISM IN TWENTIETH-CENTURY BRITISH AND AMERICAN FICTION (1–3 per semester, maximum of 12) Figures studied will be drawn from the era of Joyce and Woolf to the present.
576. STUDIES IN TWENTIETH-CENTURY AMERICAN FICTION (1–3 per semester, maximum of 12) Concentrated study in such major American writers as Hemingway, Faulkner, and Fitzgerald.
577. CONTEMPORARY FICTION (1–3 per semester, maximum of 12) Exploration of contemporary English language fiction.
578. STUDIES IN MODERN BRITISH DRAMA (1–3 per semester, maximum of 12) Figures studied will be drawn from the era of Shaw and Wilde to the present.
581. MODERN AMERICAN AND BRITISH CRITICISM TO 1965 (1–3 per semester, maximum of 12) Study of modern literary criticism to 1965, with emphasis on such figures as Winters, Richards, Eliot, and Frye.
582. SURVEY OF CONTEMPORARY LITERARY THEORY (3) Exploration of the dimensions of discourse as reflected in recent theories of rhetoric, poetics, and literary criticism.
583. STUDIES IN CRITICAL THEORY (1–3 per semester, maximum of 12) Study of specific contemporary critical approaches to literature and application to English and/or American literary works.
584. STUDIES IN RHETORIC (1–3 per semester, maximum of 12) Specific rhetorical problems, issues, or figures; topics will change from year to year.
585. STUDIES IN BRITISH FICTION (1–3 per semester, maximum of 12)
586. READINGS IN LITERATURE (1–12) Programs of readings designed to meet specific needs of individual students.
588. STUDIES IN AMERICAN FICTION (1–3 per semester, maximum of 12)
589. STUDIES IN AMERICAN POETRY (1–3 per semester, maximum of 12)
590. COLLOQUIUM (1–3)
595. INTERNSHIP (1–3 per semester, maximum of 12) Supervised practicum in fields appropriate to the English major. Prerequisite: departmental approval.
596. INDIVIDUAL STUDIES (1–9)
597. SPECIAL TOPICS (1–9)

ENTOMOLOGY (ENT)

JAMES L. FRAZIER, *Head of the Department*
501 Agricultural Sciences and Industries Building
814-863-7344

Degrees Conferred: Ph.D., M.S., M.Agr.

The Graduate Faculty

Olusola A. Adeyeye, Ph.D. (Georgia) *Adjunct Assistant Professor of Entomology*
Heidi M. Appel, Ph.D. (Michigan) *Research Associate in Entomology*
David J. Biddinger, Ph.D. (Penn State) *Adjunct Assistant Professor of Entomology*
Robert A. Byers, Ph.D. (Purdue) *Adjunct Professor of Entomology*
Dennis D. Calvin, Ph.D. (Kansas State) *Associate Professor of Entomology*
Scott M. Camazine, Ph.D. (Cornell) *Assistant Professor of Entomology*
E. Alan Cameron, Ph.D. (California) *Professor of Entomology*
Diaqa Cox-Foster, Ph.D. (Illinois) *Associate Professor of Entomology*
Shelby J. Fleischer, Ph.D. (Auburn) *Assistant Professor of Entomology*
James L. Frazier, Ph.D. (Ohio) *Head and Professor of Entomology*
Paul R. Heller, Ph.D. (Ohio State) *Professor of Entomology*
Kelli Hoover, Ph.D. (California, Davis) *Assistant Professor of Entomology*
Arthur A. Hower, Jr., Ph.D. (Penn State) *Professor of Entomology*
Larry A. Hull, Ph.D. (Penn State) *Professor of Entomology*
Ke Chung Kim, Ph.D. (Minnesota) *Professor of Entomology*

Bruce A. McPherson, Ph.D. (Illinois) *Associate Professor of Entomology*
 Christopher A. Mullin, Ph.D. (Cornell) *Professor of Entomology*
 Ralph O. Mumma, Ph.D. (Penn State) *Distinguished Professor Emeritus of Environmental Quality*
 Charles W. Pitts, Ph.D. (Kansas State) *Professor of Entomology*
 Edwin G. Rajotte, Ph.D. (Rutgers) *Associate Professor of Entomology*
 Michael C. Saunders, Ph.D. (Georgia) *Associate Professor of Entomology*
 John C. Schultz, Ph.D. (Washington) *Professor of Entomology*
 Zane Smilowitz, Ph.D. (Cornell) *Professor of Entomology*
 Robert J. Snetsinger, Ph.D. (Illinois) *Professor Emeritus of Entomology*
 Alfred G. Wheeler, Jr., Ph.D. (Cornell) *Adjunct Professor of Entomology*

Graduate study in the Entomology program seeks to develop students to assume leadership roles in science upon graduation. Students are encouraged to write research proposals, give professional presentations, and publish research articles. Emphasis is placed upon the professional development of the student. Part of the student's training is participation in professional development activities. These are selected by the student from course preparation/delivery, experience in insect identification clinics, experience in museum collection, preparation of multimedia educational materials, and entrepreneurial activities. Students are able to specialize in the research program areas of insect-plant interactions, environmental and developmental regulation of genes, artificial intelligence and modeling, population biology, ecology and biodiversity, integrated pest management, and environmental quality and application technology. Additional specialization is available to students performing research with insects in the intercollege degree programs in genetics, ecology, and plant physiology.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are required for admission. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

For admission a student should have a strong background in biological sciences. Courses in chemistry through organic, physics, mathematics through calculus, statistics, and computer application are recommended.

Master's Degree Requirements

The Master of Agriculture degree in Entomology is a terminal professional degree and is particularly suited for training chemical technical personnel, pest management specialists, and for various government staff positions. A minimum of 30 graduate credits (400 and 500 level) are required, with at least 20 credits earned in residence and 12 credits in organized Entomology courses. Required course credits include 6 credits in entomology in addition to ENT 410 (3 credits), 411 (2 credits), and 412 (3 credits), and 9 credits in a coherent series of courses in a related area or internship. Courses at the 600 level are not acceptable for the Master of Agriculture program. A maximum of 10 credits may be earned in Special Problems or 12 credits in Special Internship Training. A paper is required, for which a maximum of 3 additional credits may be given. The results of work are to be reported at a departmental seminar, and the student may register for 1 credit of ENT 590 for that semester. A final oral examination covering the general field of entomology, with emphasis in the student's area of specialization, is required by the department. This is to be administered by the student's committee. A favorable vote of a two-thirds majority is necessary for passing. These requirements must be met within three calendar years after entering the program.

The Master of Science degree in Entomology is an intermediate degree leading toward the development of special knowledge in entomology. It provides training for prospective doctoral candidates. The program requires all students to take (or have the equivalent of) ENT 410, 411, and 412, a minimum of 3 credits of statistics, and at least 4 credits of professional development. Additional courses may be selected by the student in consultation with his/her graduate committee. Each student must present the results of thesis research at a departmental seminar, and the student may register for 1 credit of ENT 590 (COLLOQUIUM) that semester. An acceptable thesis equivalent to 6 credits (600 level) is required. A final oral examination covering the general field of entomology, with emphasis in the student's area of specialization, is required by the department. This is to be administered by the student's committee. A favorable vote of a two-thirds majority is necessary for passing.

Doctoral Degree Requirements

The degree of Doctor of Philosophy signifies high scholastic achievement and demonstrated capability in independent research. Although there is no formal credit requirement, it will normally require at least three years of graduate work. Some of the work may be completed off campus or on a part-time basis, but

ENVIRONMENTAL ENGINEERING

between the time of acceptance as a candidate and completing the degree requirements the student must spend two academic sessions in residence within a twelve-month period. The department requires that all students have ENT 410, 411, and 412 or their equivalent. Other course requirements are dependent on the student's program of study. The results of the dissertation research must be presented at a departmental seminar. A minor is not required, but a student may elect a minor in general studies or a related field. This consists of no fewer than 15 credits.

There is no foreign language requirement for the Ph.D. degree. However, depending on the nature of the thesis research and with the advice and consent of the Doctoral Committee, competency in a foreign language may be required as a part of the doctoral studies of certain students. (Students are not formally admitted to the doctoral candidacy until they have passed a candidacy examination. A favorable vote by two-thirds of the committee members is necessary for acceptance of a candidate.)

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

ENTOMOLOGY (ENT)

- 402. (V SC) BIOLOGY OF ANIMAL PARASITES (3)
- 410. INSECT STRUCTURE AND FUNCTION (3)
- 411. LABORATORY INVESTIGATIONS INTO INSECT STRUCTURE AND FUNCTION (2)
- 412. INSECT TAXONOMY (3)
- 420. INTRODUCTION TO POPULATION DYNAMICS (3)
- 425. FRESHWATER ENTOMOLOGY (3)
- 430. (BIOL, B M B) DEVELOPMENTAL BIOLOGY (3)
- 455. ECONOMIC ENTOMOLOGY (3)
- 456. METHODS AND STRATEGIES FOR INSECT PEST MANAGEMENT (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

- 530. HOST PLANT RESISTANCE TO INSECTS (2) Evaluation and identification of plant resistance to insect and mite attack. Prerequisites: 10 credits in entomology and/or plant science.
- 539. CHEMICAL ECOLOGY OF INSECTS (3) Interactions of insects with environmental chemicals, including natural and synthetic compounds; host findings and other behavior modifying cues.
- 542. (BIOL, W F S) SYSTEMATICS (3) Principles and methods of classification, phylogeny, and speciation; taxonomic techniques; analysis of species; causal interpretation of animal diversity.
- 543. BIOLOGICAL CONTROL AND PATHOLOGY OF INSECTS (3) Arthropod population control by entomogenous insects and microorganisms. Prerequisite: consent of program.
- 550. ADVANCED INTEGRATED PEST MANAGEMENT (2) Understand the design, implementation, and analysis of IPM programs under varying social, political, environmental, and economic constraints. Prerequisite: ENT 456.
- 590. COLLOQUIUM (1-3)
- 593. (ANTH, BIOL, GEOSC, INTAG) TROPICAL FIELD STUDIES (Organization for Tropical Studies) (8) An intensive field course concentrating on field problems, experimental design, and data analysis in tropical habitats. Prerequisite: approval by the Committee on Tropical Studies.
- 595. INTERNSHIP (10-12) Supervised field experience and study related to the student's major professional interest. Written and oral critique of activity required. Limited to students for Master of Agriculture degree in entomology. Prerequisites: approval of proposed assignment by adviser prior to registration; cumulative G.P.A. of 3.00 or higher; completion of entomology core courses.
- 596. INDIVIDUAL STUDIES (1-9)
- 597. SPECIAL TOPICS (1-9)

ENVIRONMENTAL ENGINEERING (ENV E)

PAUL P. JOVANIS, *Head of the Department of Civil and Environmental Engineering*
212 Sackett Building
814-863-3084

Degrees Conferred: Ph.D., M.S., M.Eng.

The Graduate Faculty

Ana P. Barros, Ph.D. (Washington) *Associate Professor of Civil Engineering*

William D. Burgos, Ph.D. (Virginia Tech) *Assistant Professor of Environmental Engineering*

Fred S. Cannon, Ph.D. (Illinois, Urbana-Champaign) *P.E. Assistant Professor of Environmental Engineering*

Brian A. Dempsey, Ph.D. (North Carolina) *Associate Professor of Environmental Engineering*

Christopher J. Duffy, Ph.D. (New Mexico Institute of Mining and Technology) *P.H. Associate Professor of Civil Engineering*

Peggy A. Johnson, Ph.D. (Maryland) *Associate Professor of Civil Engineering*

Bruce E. Logan, Ph.D. (California, Berkeley) *Kappe Professor of Environmental Engineering*

Jack V. Matson, Ph.D. (Rice) *P.E. Professor of Environmental Engineering*

Archibald J. McDonnell, Ph.D. (Penn State) *Professor of Environmental Engineering*

Arthur C. Miller, Ph.D. (Colorado State) *P.E., P.L.S. Professor of Civil Engineering*

Raymond W. Regan, Sr., Ph.D. (Kansas) *P.E. Professor of Environmental Engineering*

Lily Shehaye, Ph.D. (Rutgers) *Assistant Professor of Environmental Engineering (non-tenure-track)*

Penn State Great Valley

Richard F. Unz, Ph.D. (Rutgers) *Professor of Environmental Microbiology*

Gour-Tsyh Yeh, Ph.D. (Cornell) *P.E. Professor of Civil Engineering*

This specialty prepares students for careers in the design of treatment facilities, environmental monitoring, process development for water quality control, industrial waste treatment, management of hazardous and toxic substances, monitoring and management of environmental quality, air pollution control, and water resource systems.

Admission Requirements

The requirements listed here are in addition to the general requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Candidates should possess a baccalaureate degree from an accredited institution. Students with a 3.00 junior/senior grade-point average (on a 4.00 scale) and appropriate course backgrounds may be considered for admission. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

Applicants must provide the department with official transcripts of all of their previous course work (in duplicate), a statement of objectives, and three letters of recommendation AT THE TIME OF APPLICATION. Résumés are encouraged, but not required. In addition, all applicants must submit scores from the General Graduate Record Examination Aptitude Test (verbal, quantitative, and analytical).

The Graduate Record Examination (GRE) program will change significantly in 1999, and this change will affect the graduate admission requirements for the Department of Civil and Environmental Engineering. After the new GRE is introduced, applicants should take the package of the General Test measures containing the Mathematical Reasoning test.

All international applicants whose native language is not English must present an acceptable score (560 minimum on the paper-based test; 220 minimum on the computer-based test) on the Test of English as a Foreign Language (TOEFL).

Applicants for fall admission who wish to be considered for financial aid should have COMPLETED applications on file by OCTOBER 31.

Degree Requirements

A thesis is required for the M.S. degree. A writing portfolio is required for the M.Eng. degree. In addition to demonstrating competence in English, each candidate for the Ph.D. degree must satisfy the associated research and communication skills requirements established by the department.

Continuous registration is required for all graduate students until the thesis or writing portfolio is approved.

Other Relevant Information

The following courses offered by the Department of Civil and Environmental Engineering are appropriate for students majoring in Environmental Engineering (course descriptions are given under Civil Engineering): C E 451, 462, 465W, 472W, 474, 475, 476, 477, 479, 496, 497, 551, 555, 556, 557, 558, 561, 562, 564, 570, 571, 572, 573, 574, 575, 577, 579, 580, 596, 597, and 598. Appropriate courses offered by other departments include, but are not limited to: B M B 401, 402; CHEM 405; GEOSC 452; M E 405, 470, 521; METEO 454; MICRB 400; NUC E 420.

ENVIRONMENTAL POLLUTION CONTROL

Student Aid

Graduate assistantships and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*. International applicants who wish to be considered for a teaching assistantship must present an acceptable score (250–300 or 55–60) on the Test of Spoken English (TSE). The TSE can be taken in many countries, or at Penn State after arrival.

CECIL M. PEPPERMAN MEMORIAL GRADUATE FELLOWSHIP—Available to a graduate student in civil or environmental engineering specializing in one of the following fields, listed in order of priority: waste treatment and management, water pollution control, environmental engineering, or related fields.

ENVIRONMENTAL POLLUTION CONTROL (E P C)

HERSCHEL A. ELLIOTT, *In Charge of Graduate Programs in Environmental Pollution Control*
207 Agricultural Sciences and Industries Building, University Park campus
814-865-1417

RICHARD S. HUEBNER, *Associate Chair, Environmental Program, Penn State Harrisburg*
W-209 Olmsted Building, Penn State Harrisburg
717-948-6358

LILY SEHAYEK, *Associate Chair, Environmental Pollution Control Program, Penn State Great Valley*
610-648-3373

Degrees Conferred: M.S., M.E.P.C., M.Eng. (University Park Campus)
M.S., M.E.P.C., M.Eng. (Penn State Harrisburg)
M.E.P.C. (Penn State Great Valley)

The Graduate Faculty—University Park Campus

David G. Abler, Ph.D. (Chicago) *Associate Professor of Agricultural Economics*
Michael A. Adewumi, Ph.D. (Illinois Institute of Tech) *Associate Professor of Petroleum and Natural Gas Engineering*
Linda Angell, D.B.A. (Boston U) *Assistant Professor of Operations Management*
Jean-Marc Bollag, Ph.D. (Basel) *Professor of Soil Microbiology*
Christopher J. Bise, Ph.D. (Penn State) *Professor of Mining Engineering*
Andre L. Boehman, Ph.D. (Stanford) *Assistant Professor of Fuel Science*
William H. Brune, Ph.D. (Johns Hopkins) *Professor of Meteorology*
Subhash Chander, Ph.D. (California, Berkeley) *Professor of Mineral Processing*
Jon D. Chorover, Ph.D. (California) *Assistant Professor of Environmental Soil Chemistry*
Rick L. Day, Ph.D. (Penn State) *Affiliate Assistant Professor of Soil and Land Resources*
Brian A. Dempsey, Ph.D. (North Carolina) *Associate Professor of Environmental Engineering*
David R. DeWalle, Ph.D. (Colorado State) *Professor of Forest Hydrology*
Herschel A. Elliott, Ph.D. (Delaware) *Professor of Agricultural Engineering*
Derek Elsworth, Ph.D. (California, Berkeley) *Associate Professor of Mining Engineering*
Irwin Feller, Ph.D. (Minnesota) *Professor of Economics*
Richard L. Gordon, Ph.D. (MIT) *Professor of Mineral Economics*
Michael W. Grutzeck, Ph.D. (Penn State) *Senior Research Associate and Associate Professor of Materials*
James M. Hamlett, Ph.D. (Iowa State) *Associate Professor of Agricultural Engineering*
Paul J. Hicks, Ph.D. (Houston) *Assistant Professor of Petroleum and Natural Gas Engineering*
Richard Hogg, Ph.D. (California, Berkeley) *Professor of Mineral Processing*
Albert R. Jarrett, Ph.D. (Penn State) *Professor of Agricultural Engineering*
Dennis Lamb, Ph.D. (Washington) *Associate Professor of Meteorology*
James A. Lynch, Ph.D. (Penn State) *Professor of Forest Hydrology*
Thomas H. Martin, Ph.D. (North Carolina State) *Assistant Professor of Aquatic Ecology*
Jack V. Matson, Ph.D. (Rice) P.E. *Professor of Civil Engineering*
Arthur C. Miller, Ph.D. (Colorado State) P.E. *Professor of Civil Engineering*
Dennis J. Murphy, Ph.D. (Penn State) C.S.P. *Professor of Agricultural Engineering*
Richard R. Parizek, Ph.D. (Illinois) *Professor of Geology*
Gary W. Petersen, Ph.D. (Wisconsin) *Professor of Soil Genesis and Morphology*

Sarma V. Pisupati, Ph.D. (Penn State) *Assistant Professor of Fuel Science*
 Raymond W. Regan, Sr., Ph.D. (Kansas), P.E. *Professor of Civil Engineering*
 Paul D. Robillard, Ph.D. (Cornell) *Associate Professor of Agricultural Engineering*
 Adam Z. Rose, Ph.D. (Cornell) *Professor of Energy, Environmental, and Mineral Economics*
 Barry F. Scheetz, Ph.D. (Penn State) *Senior Scientist and Professor of Materials*
 Robert D. Shannon, Ph.D. (Indiana) *Assistant Professor of Agricultural Engineering*
 William E. Sharpe, Ph.D. (West Virginia) *Professor of Forest Hydrology*
 James Shortle, Ph.D. (Iowa State) *Professor of Agricultural Economics*
 Dennis W. Thomson, Ph.D. (Wisconsin) *Professor of Meteorology*
 Richard F. Unz, Ph.D. (Rutgers) *Professor of Environmental Microbiology*
 William B. White, Ph.D. (Penn State) *Professor of Geochemistry*
 John C. Wyngaard, Ph.D. (Penn State) *Professor of Meteorology*

The Graduate Faculty—Penn State Great Valley

Robert Hartman, Ph.D. (Delaware) *Associate Professor of Mechanical Engineering*
 Kathryn Jablowski, Ph.D. (Ohio State) *Associate Professor of Mechanical Engineering*
 Eugene Kozik, Ph.D. (Pittsburgh) *Associate Professor of Industrial and Manufacturing Engineering*
 John I. McCool, Ph.D. (Temple) *Associate Professor of Industrial and Manufacturing Engineering*
 David W. Russell, Ph.D. (London) *Professor of Electrical Engineering*
 Lily Sehayek, Ph.D. (Rutgers) *Assistant Professor of Environmental Engineering*
 James Weisbecker, Ph.D. (Temple) *Assistant Professor of Computer Science*

The Graduate Faculty—Penn State Harrisburg

Katherine H. Baker, Ph.D. (Delaware) *Assistant Professor of Environmental Microbiology*
 Melvin Blumberg, Ph.D. (Penn State) *Professor of Management*
 Rupert F. Chisholm, Ph.D. (Case Western Reserve) *Professor of Management*
 Beverly A. Cigler, Ph.D. (Penn State) *Professor of Public Administration and Public Policy*
 Charles A. Cole, Ph.D. (Rutgers) *Professor of Engineering*
 Krishna S. Dhir, Ph.D. (Colorado) *Professor of Business Administration*
 Richard S. Huebner, Ph.D. (Penn State) *Assistant Professor of Engineering*
 Samuel A. McClintock, Ph.D. (Virginia Tech) *Associate Professor of Environmental Engineering*
 Christopher K. McKenna, Ph.D. (NYU) *Associate Professor of Management Science*
 Robert F. Munzenrider, Ph.D. (Georgia) *Associate Professor of Public Administration*
 George P. Partridge, Ph.D. (Tennessee) *Assistant Professor of Engineering*
 Howard G. Sachs, Ph.D. (Clark) *Professor of Biology*
 James E. Skok, Ph.D. (Maryland) *Associate Professor of Public Administration*
 Clifford H. Wagner, Ph.D. (SUNY) *Associate Professor of Mathematics and Computer Science*
 Yuefeng Xie, Ph.D. (Tsinghua) *Assistant Professor of Environmental Engineering*

This intercollege master's degree program, available at University Park campus, Penn State Harrisburg, and Penn State Great Valley, deals with the various aspects of air, land, and water pollution control. Graduate instruction is under the direction of an interdisciplinary faculty committee and the departments participating in the program. The EPC faculty have teaching and research interests in the area of environmental pollution control, and, where projects are being funded, support opportunities may be available. Currently, forty faculty from sixteen departments in six colleges are participating in the program at University Park campus; fourteen faculty from four graduate programs participate at Penn State Harrisburg, and seven faculty from Penn State Great Valley. A student is affiliated with one of these departments on the basis of his/her specific area of interest and is advised by an EPC faculty member in that department. Maximum flexibility is maintained by the program in an effort to meet both the needs of the individual student and the pollution control activity in which he/she wants to participate.

Admission Requirements

Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

The EPC program is designed for students with backgrounds in science or engineering. Admission will be granted if the applicant has the necessary program prerequisites and a faculty member in the student's interest area agrees to serve as adviser. Normal admission requirements include mathematics through integral calculus plus two courses each in both general chemistry and physics.

Students with a 3.00 junior/senior average and with appropriate backgrounds in mathematics and science will be considered for admission. The best-qualified applicants will be admitted up to the number of places

EPC CONCURRENT DEGREE

that are available for new students. Applicants to the Environmental Pollution Control program are required to provide a statement of objectives, three letters of recommendation, and scores from the Graduate Record Examination (GRE) Aptitude Test (verbal, quantitative, analytical) to complete the admission process. (Entering graduate students for whom English is not their first language are required to have a score of at least 560 on the TOEFL (Test of English as a Foreign Language) examination. There is no foreign language requirement.

Degree Requirements

All candidates are required to take a core course in each of four environmental areas—air, water, solid waste, hazardous waste management, and policy/risk—and 1 credit of the E P C 590 seminar for a minimum core requirement of 12 credits. All but 6 of the total 30 credits required must be selected from a recommended course list. If the option to prepare a thesis is selected (M.S. only), students must schedule at least 12 credits at the 500 level, take at least 6 credits of 600-level thesis research in their thesis adviser's academic department, and write a thesis on an area concerned with environmental pollution. Only 6 credits of 600-level course work may count toward the 30-credit minimum degree requirement. Students who select the nonthesis option must schedule at least 15 credits at the 500 level, which may include 1 credit of E P C 590 and a maximum of 3 paper-writing credits. The M.E.P.C. and M.Eng. E P C degrees require submission of a scholarly master's paper.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

ENVIRONMENTAL POLLUTION CONTROL (E P C)

590. COLLOQUIUM (1)

EPC CONCURRENT DEGREE OFFERING WITH THE PENN STATE DICKINSON SCHOOL OF LAW

Penn State Harrisburg School of Science, Engineering, and Technology

Penn State Dickinson School of Law

Degrees Conferred: J.D. (Dickinson)

M.Eng., M.E.P.C., M.S. (Penn State Harrisburg)

The Penn State Dickinson School of Law and the Intercollege Graduate Program in Environmental Pollution Control (EPC) offer a coordinated program leading to the degrees of Juris Doctor (J.D.) and Master of Environmental Pollution Control (M.E.P.C.), Master of Engineering in EPC (M.Eng.), or Master of Science in EPC (M.S.).

The EPC programs are interdisciplinary, dealing with all aspects of controlling air, water, and solid waste pollution and disposal. The master of engineering degree is designed for those with an undergraduate degree in engineering, while the master of environmental pollution control degree is for those with science or nontechnical backgrounds. The master of science degree is intended for those students who wish to intensively pursue a research area as part of their master's degree work.

Admission to the program: In order to be admitted to the program, students must first be admitted to Dickinson under its regular admission procedures. Students are admitted to begin classes in the fall only. Dickinson will screen potential program candidates, and need not forward applications of all Dickinson admittees who have expressed an interest in the EPC programs. Dickinson can withhold support for some admittees until they have demonstrated proficiency in their legal studies and a capacity for dual-degree study. The EPC program will make an independent admission decision as to all dual-degree applicants.

Admission Requirements

a. Dickinson. A bachelor's or equivalent degree from an accredited college is a prerequisite for admission. However, there is no standard prescribed undergraduate curriculum. An applicant should have acquired significant oral and written communication skills before entering law school. The following are required of applicants: complete application form for Dickinson; taking of the Law School Admission Test (LSAT); completion of an LSDAS report; a one-page personal statement; employment record since high school; two recommendations.

b. EPC. A bachelor's degree in engineering from an accredited program is required for the Master of Engineering degree program. For the Environmental Pollution Control program, a bachelor's degree is required, including courses in mathematics through integral calculus and two courses each in both general physics and chemistry. If the applicant has not had experience with aspects of environmental engineering or science, completion of ENVE 397 Introduction to Environmental Engineering and Science or C E 297B Water Pollution Control is strongly suggested prior to the start of the graduate course work in the program. A completed Graduate School application form also is required.

Sequence: Students complete the first year of the J.D. program before beginning the EPC program. (While students might take courses in the EPC program prior to enrollment at Dickinson, credit for those courses may not count toward the J.D. degree.) Thereafter, students may concurrently enroll in courses in the J.D. and EPC program, provided that they abide by the requirements of each program.

Interprogram Transfer of Credits

a. J.D. A maximum of 12 credits for EPC course work may be transferred for credit toward the J.D. degree at Dickinson. Courses for which such credit may be applied shall be subject to approval by the Dickinson faculty. Students must obtain a grade satisfactory to Dickinson for the course work to be credited toward the J.D. degree.

b. MEPC. A maximum of 12 credits of Dickinson course work may be counted for credit toward this degree, subject to EPC approval based on the relevance to the MEPC degree program. No course work at Dickinson may be used to satisfy the master's paper requirement of the MEPC degree program. However, a member of the Penn State graduate faculty from Dickinson may be designated as a reader for the master's project.

c. M.S. or M.Eng. in EPC. A maximum of 8 credits of Dickinson course work may be counted for credit toward this degree, subject to EPC approval based on relevance to the degree program. No course work at Dickinson may be used to satisfy the master's paper requirement of the M.Eng. degree program or the thesis requirement of the M.S. degree. However, a member of Penn State graduate faculty from Dickinson may be designated as a reader for the master's project.

Recommended Program of Study and Advising: All students in the program have two advisers, one from Dickinson and one from EPC. Periodic interaction between the two advisers is encouraged. A program of study is developed for each student, taking into account the fact that some courses at both locations are offered on a rotating basis. Many courses are offered every year, but some are offered every two or three years. Advisers will have available a list of projected relevant offerings in order to work with the student on an individualized program of study.

Tuition: Students will be charged the applicable Dickinson tuition to cover the J.D. program and graduate tuition on a per credit (in-state) rate of the EPC courses.

Graduation: A student in the program may complete the requirements for one of the degrees, and be awarded that degree, prior to completing all the requirements for the other degree. All courses in one program that will count toward meeting the requirements of the other program must be completed before awarding the first degree.

EXTENSION EDUCATION (EXTED)

EDGAR P. YODER, *Chair of the Committee on Extension Education*
323 Agricultural Administration Building
814-863-7852

Degrees Conferred: M.Agr., M.Ed.

The Graduate Faculty

Phyllis F. Adams, Ph.D. (Oklahoma State) *Associate Professor of Agricultural and Extension Education*
Blannie E. Bowen, Ph.D. (Ohio State) *Professor of Agricultural and Extension Education*
Cathy F. Bowen, Ph.D. (Ohio State) *Assistant Professor of Agricultural and Extension Education*
O. Elwood Hatley, Ph.D. (Purdue) *Associate Professor of Agronomy*
Daryl K. Heasley, Ph.D. (Penn State) *Associate Professor of Rural Sociology*
Robert B. Lewis, D.Ed. (North Carolina State) *Professor of 4-H Youth*
Dennis J. Murphy, Ph.D. (Penn State) *Associate Professor of Agricultural Engineering*
Michael D. Orzolek, Ph.D. (Maryland) *Professor of Vegetable Crops*
Timothy J. Rollins, Ph.D. (Iowa State) *Associate Professor of Agricultural and Extension Education*
Jan F. Scholl, Ph.D. (Iowa State) *Associate Professor of Agricultural and Extension Education*
Robert J. Snetsinger, Ph.D. (Illinois) *Professor of Entomology*

FOOD SCIENCE

Joan S. Thomson, Ph.D. (Wisconsin) *Associate Professor of Rural Sociology*
Paul J. Wuest, Ph.D. (Penn State) *Professor of Plant Pathology*

This program is designed to meet the graduate study needs of professionals in various extension, vocational, and adult education positions. Students are required to select a committee to assist in defining professional goals, planning a program of study, selecting appropriate courses, and developing a professional paper within the requirement of the degree program.

Specific objectives of the Extension Education program are (1) to provide a comprehensive program of study that focuses on developing, evaluating, and administering nonformal education programs; (2) to promote an awareness and understanding of significant research in the area of Extension Education; (3) to increase the professional effectiveness of extension personnel; (4) to provide experience for extension personnel or other educators in applying research methodology and problem-solving techniques.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Degree Requirements

For either degree, a minimum of 30 credits is required, including a 3-credit professional paper. These credits should be distributed as follows: 12 credits in extension techniques, communication, and education; 3-4 credits in statistics; 6-12 credits in a minor area of interest; and 3 credits for the professional paper. For the M.Ed. degree, a minimum of 6 credits in education courses is required. Students must take 12 of the 27 credits in course work at the 500 level. A maximum of 10 credits may be earned as a nonresident student.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

EXTENSION EDUCATION (EXTED)

- 440. (AG ED) COMMUNICATION METHODS AND MEDIA (3)
- 450. (AG ED) METHODOLOGY OF EXTENSION EDUCATION (3)
- 455. 4-H/EXTENSION YOUTH PROGRAMS AND VOLUNTEER MANAGEMENT (3)
- 495. INTERNSHIP (6-18)
- 496. INDEPENDENT STUDIES (1-18)
- 497, 498. SPECIAL TOPICS (1-9)

515. (R SOC) THE COOPERATIVE EXTENSION ORGANIZATION (3) The Cooperative Extension Service as a social system, with emphasis on techniques of organization and program development. Prerequisites: 9 credits in education, communication, and/or social sciences.

555. VOLUNTEER PROGRAM MANAGEMENT (3) The study and application of concepts and principles of volunteerism and administration relevant to volunteer program management. Prerequisites: R SOC 305W or 505.

- 590. COLLOQUIUM (1-3)
- 596. INDIVIDUAL STUDIES (1-9)
- 597. SPECIAL TOPICS (1-9)

FOOD SCIENCE (FD SC)

DONALD B. THOMPSON, *Head of the Department*
111 Borland Laboratory
814-863-2950

Degrees Conferred: Ph.D., M.S.

The Graduate Faculty

Ramaswamy C. Anantheswaran, Ph.D. (Cornell) *Associate Professor of Food Science*
 Robert B. Beelman, Ph.D. (Ohio State) *Professor of Food Science*
 J. Lynne Brown, Ph.D. (MIT) *Associate Professor of Food Science*
 John N. Coupland, Ph.D. (Leeds) *Assistant Professor of Food Science*
 Stephanie Doores, Ph.D. (Maryland) *Associate Professor of Food Science*
 Hassan Gourama, Ph.D. (Nebraska) *Associate Professor of Food Science*
 Arun Kilara, Ph.D. (Nebraska) *Professor of Food Science*
 Stephen J. Knabel, Ph.D. (Iowa State) *Associate Professor of Food Science*
 Manfred Kroger, Ph.D. (Penn State) *Professor of Food Science*
 Luke F. LaBorde, Ph.D. (Wisconsin—Madison) *Assistant Professor of Food Science*
 Audrey Maretzki, Ph.D. (Pittsburgh) *Professor of Food Science and Nutrition*
 Karen J. Miller, Ph.D. (Massachusetts) *Associate Professor of Food Science*
 Robert F. Roberts, Ph.D. (Minnesota) *Associate Professor of Food Science*
 Donald B. Thompson, Ph.D. (Illinois) *Associate Professor of Food Science*
 Gregory R. Ziegler, Ph.D. (Cornell) *Associate Professor of Food Science*

In the Department of Food Science, students are exposed to a multidisciplinary, integrated approach to teaching and research relevant to processing and manufacture of value-added foods from agricultural commodities. Through integration of the disciplines of chemistry, microbiology, engineering, and nutrition, students help ensure that consumers can make healthful choices from an abundant supply of affordable, safe, nutritious, and appealing foods. Graduate work leading to the M.S. and Ph.D. degrees in Food Science is directed toward establishing the individual as a professional leader and an independent scholar capable of tending to his or her own professional education needs for the rest of his or her life.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are required for admission. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Students with a 3.00 junior/senior average (on a 4.00 scale) will be considered for admission to the program. Exceptions may be made for students with special backgrounds, abilities, and interests.

Best preparation for graduate work would be the completion of an undergraduate degree in food science, biochemistry, microbiology, or other related areas. The undergraduate program must include calculus, organic chemistry, microbiology, and general physics. Students may be admitted with deficiencies but are required to make them up without degree credit.

Students are generally admitted directly to a master's program unless they have previously earned an M.S. degree in food science or an appropriate related area; in such cases, admission can be made directly to the doctoral program by approval of the graduate program committee.

Master's Degree Requirements

The requirements for the M.S. program are detailed in the Department of Food Science's publication "Graduate Studies in Food Science at Penn State." Minimum course requirements for the M.S. degree are as follows: Colloquium (FD SC 590), 1 credit; Orientation (FD SC 596A), 1 credit; Supervised Experience in College Teaching (FD SC 602), 1 credit; Food Chemistry (FD SC 400 or equivalent), Food Microbiology (FD SC 408 or equivalent), Food Engineering (ASM 425 or equivalent), Nutrition (FD SC 406 or equivalent), Statistics (STAT 451 or equivalent), Biochemistry (B M B 401 or equivalent); research (FD SC 600 or 601), 6 credits.

Doctoral Degree Requirements

The requirements for the Ph.D. program are detailed in the Department of Food Science's publication "Graduate Studies in Food Science at Penn State."

Minimum course requirements for the Ph.D. degree are as follows: Colloquium (FD SC 590), 1 credit; Orientation (FD SC 596A), 1 credit; Supervised Experience in College Teaching (FD SC 602), 2 credits; Food Chemistry (FD SC 400 or equivalent), Food Microbiology (FD SC 408 or equivalent), Food Engineering (ASM 425 or equivalent), Nutrition (FD SC 406 or equivalent), Statistics (STAT 451 or equivalent), Biochemistry (B M B 401 or equivalent).

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

ROEST RESOURCES

FOOD SCIENCE (FD SC)

- 400. FOOD CHEMISTRY (3)
 - 402. FOOD CHEMISTRY LAB (1)
 - 404. SENSORY EVALUATION OF FOODS (2)
 - 406. PHYSIOLOGY OF NUTRITION (3)
 - 407. FOOD TOXINS (2)
 - 408. APPLIED FOOD MICROBIOLOGY (2)
 - 409W. LABORATORY IN APPLIED FOOD MICROBIOLOGY (3)
 - 410. CHEMICAL METHODS OF FOOD ANALYSIS (3)
 - 411. MANAGING FOOD QUALITY (2)
 - 412. LABORATORY IN MANAGING FOOD QUALITY (1)
 - 413. SCIENCE AND TECHNOLOGY OF PLANT FOODS (3)
 - 414. SCIENCE AND TECHNOLOGY OF DAIRY FOODS (4)
 - 415. SCIENCE AND TECHNOLOGY OF MUSCLE FOODS (3)
 - 417. FOOD LAWS AND REGULATIONS (2)
 - 430. UNIT OPERATIONS IN FOOD PROCESSING (3)
 - 495. INTERNSHIP (1-18)
 - 496. INDEPENDENT STUDIES (1-18)
 - 497. SPECIAL TOPICS (1-9)
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- 505. CONCEPTS OF PRODUCT DEVELOPMENT (2) Procedures and problems encountered in the development of new and modified food products. Idea generation through development, testing, and commercialization.
 - 508. FOOD PROTEINS (3) Properties and uses of proteins in food systems. Prerequisites: BIOCH 401, FD SC 400.
 - 509. ENZYMES AND BIOTECHNOLOGY (3) The technological application of enzymes in foods, with special emphasis on biotechnology, production, and purification of enzymes. Prerequisites: BIOCH 401, FD SC 400.
 - 510. CARBOHYDRATE HYDROCOLLOIDS (3) Physicochemical behavior of edible carbohydrate hydrocolloids, with emphasis on starch and selected exudates, extracts, flours, and fermentation products. Prerequisite: BIOCH 401.
 - 512. CONCEPTS IN FOOD MICROBIOLOGY (3) In-depth analysis of the microbial response to environmental challenges including temperature, water activity, pH, atmosphere, and food preservatives. Prerequisite: FD SC 408.
 - 505. THERMAL PROCESSING (3) Thermobacteriology, establishment and verification of thermal processes, process deviations, processing equipment, and aseptic processing. Prerequisites: A S M 425, FD SC 408.
 - 590. COLLOQUIUM (1-3)
 - 596. INDIVIDUAL STUDIES (1-9)
 - 596A. ORIENTATION (1)
 - 597. SPECIAL TOPICS (1-9)

FOREST RESOURCES (FOR R)

LARRY A. NIELSEN, *Director of the School of Forest Resources*
113 Ferguson Building
814-863-7093

Degrees Conferred: Ph.D., M.S., M.Agr., M.F.R.

The Graduate Faculty

Roy D. Adams, Ph.D. (Washington State) *Associate Professor of Wood Products*
Marc D. Abrams, Ph.D. (Michigan State) *Associate Professor of Forest Ecology and Physiology*
Timothy R. Baker, Ph.D. (North Carolina State) *Assistant Professor of Forestry*
Paul R. Blankenhorn, Ph.D. (Penn State) *Professor of Wood Technology*
Todd W. Bowersox, Ph.D. (Penn State) *Professor of Silviculture*
John E. Carlson, Ph.D. (Illinois) *Associate Professor of Molecular Genetics*
David R. DeWalle, Ph.D. (Colorado State) *Professor of Forest Hydrology*
James C. Finley, Ph.D. (Penn State) *Associate Professor of Forest Resources*

Henry D. Gerhold, Ph.D. (Yale) *Professor of Forest Genetics*
 John J. Janowiak, Ph.D. (Washington State) *Associate Professor of Forest Products*
 Peter Labosky, Ph.D. (Virginia Polytechnic) *Professor of Wood Science and Technology*
 James A. Lynch, Ph.D. (Penn State) *Professor of Forest Hydrology*
 Larry H. McCormick, Ph.D. (Penn State) *Professor of Forest Resources*
 Mary E. McDill, Ph.D. (Virginia Tech) *Assistant Professor of Forest Resource Management*
 Wayne L. Myers, Ph.D. (Michigan) *Associate Professor of Forest Biometrics*
 William E. Sharpe, Ph.D. (West Virginia) *Professor of Forest Hydrology*
 Paul M. Smith, Ph.D. (Virginia Polytechnic) *Associate Professor of Forest Products Marketing*
 Kim C. Steiner, Ph.D. (Michigan State) *Professor of Forest Biology*
 Charles H. Strauss, Ph.D. (Penn State) *Professor of Forest Economics*
 Grace A. Wang, Ph.D. (Minnesota) *Assistant Professor of Natural Resource Policy*

The Doctor of Philosophy and the Master of Science degree programs are oriented toward research, education, and scientific technology in the professions of forest products and forestry. The Master of Forest Resources is a professional degree that emphasizes application of knowledge through managerial practices involving forest resources, industries, or the natural environments of communities and recreational areas. The Master of Agriculture is intended to enable students to develop skills as professionals in the communication of technical knowledge.

Faculty expertise, laboratories, and outdoor facilities are available to support specialization in a variety of fields. Possibilities for specialization are indicated in part by the courses listed under forest products, forestry, and wildlife, and by related courses in agricultural economics, agronomy, animal nutrition, biology business administration, chemical engineering, computer science, ecology, economics, entomology, environmental pollution control, environmental resource management, genetics, horticulture, industrial engineering, landscape architecture, meteorology, physiology, plant pathology, polymer sciences, recreation and parks, regional planning, or statistics.

Students in this program may elect the dual-degree program option in Operations Research for the Ph.D. and M.S. degrees. (*See also* Operations Research.)

Admission Requirements

Scores from the Graduate Record Examination (GRE) are required for admission. A student may be admitted provisionally without GRE scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Application materials should be submitted before February by those who want to begin in summer or fall. For admission, an applicant should have at least a 2.75 grade-point average, a 3.00 junior/senior average (on a 4.00 scale), and courses that are basic to the individual's field of specialization. Ordinarily, these include 12 credits in communication; 12 credits in social sciences and humanities; 10 credits in quantification, including calculus and statistics; 8 credits in chemistry and/or physics; 8 credits in biological sciences; and 18 credits in forest products, forestry, fish, wildlife, or related courses. Three reference letters and a brief statement describing the applicant's academic goals, career interests, and special qualifications are required. The best-qualified applicants will be accepted up to the number of spaces available. Exceptions to admission requirements may be made for students with special backgrounds, abilities, and interests.

Admission to the Ph.D. program in Forest Resources requires a completed master's thesis or a B.S. with experience in research and publication.

Master's Degree Requirements

M.S.: In addition to Graduate School requirements, 6 credits of statistics and 2 credits of colloquium are required.

M.F.R.: A minimum of 30 graduate credits (400- to 600-level courses) is required, of which at least 20 must be earned at an established graduate campus of the University. At least 12 credits must be formal courses at the 500 level related to forest resources. A paper (3-6 credits of FOR/FP/WFS 596) is included as part of the 30 credits, demonstrating an ability to apply the knowledge gained during the program to the specialized field of interest; the paper will be evaluated by the student's committee. Two credits of colloquium and 3 credits of statistics (400 or 500 level) are required.

M.Agr.: Candidates will elect a minimum of 15 credits of graduate-level communications courses in majors such as Agricultural and Extension Education, English, Instructional Media, Journalism, Mass Communications, Recreation and Parks, Speech Communication, and Theatre Arts. Any deficiencies in a student's resource specialty, as judged by his or her advisory committee, must be remedied. An acceptable paper on a selected professional problem or a report of internship training worth 3 credits or more also is required.

Doctoral Degree Requirements

An international communications or cultural requirement is required for the Ph.D. degree. This requirement may be satisfied by demonstrating competence in one foreign language equivalent to passing two or three college-level courses. It also may be met by two courses in one or two contemporary foreign cultures. With approval of the doctoral committee, a student may petition the graduate faculty of the school for waiver of the international communications or culture requirement.

Postbaccalaureate course work will include courses specified for the M.S. degree plus 2 credits of colloquium. The entire program of courses tailored to the student's objectives is subject to approval of the student's committee.

The comprehensive examination will consist of an oral and written portion, the written coming first. Copies of the student's thesis research proposal should be provided to the committee before the comprehensive examination.

Other Relevant Information

Each entering student receives individual guidance from an adviser, and later from his or her committee, in designing a program of studies and research based on his or her own interests. The student is responsible for conforming to all requirements summarized in the "Graduate Studies Handbook" of the School of Forest Resources, and for completing the degree program within a reasonable time, i.e., two years for a master's degree or three years for a Ph.D.

Student Aid

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AID section of the *Graduate Bulletin*, the following awards typically have been available to graduate students in this program:

FOREST RESOURCES: JESSE ROSSITER RAPP MEMORIAL SCHOLARSHIP

—Available to graduate students. Apply to the School of Forest Resources' Scholarships, Loans, and Awards Committee.

FORESTRY (FOR)

- 401. URBAN FOREST MANAGEMENT (3)
- 403. DENDROLOGY (3)
- 409. TREE PHYSIOLOGY (2)
- 416. FOREST RECREATION (3)
- 421. SILVICULTURE (3)
- 430. (W F S) CONSERVATION BIOLOGY (3)
- 440. FOREST ECONOMICS AND FINANCE (3)
- 451. (AG) ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS FOR AGRICULTURAL AND NATURAL RESOURCE MANAGEMENT (3)
- 455. REMOTE SENSING AND SPATIAL DATA HANDLING (3)
- 466W. FOREST RESOURCE MANAGEMENT (3)
- 470. WATERSHED MANAGEMENT (3)
- 471. WATERSHED MANAGEMENT LABORATORY (1)
- 475. PRINCIPLES OF FOREST SOILS MANAGEMENT (3)
- 480. POLICY AND ADMINISTRATION (3)
- 488W. INTERNATIONAL FORESTRY (3)
- 494. FORESTRY RESEARCH (3)
- 495. FORESTRY INTERNSHIP (1–6)
- 496. INDEPENDENT STUDIES (1–18)
- 497. SPECIAL TOPICS (1–9)

- 508. FOREST ECOLOGY (3) The forest ecosystem, variations in space and time, classification, ordination techniques, dynamic aspects such as energy flow and nutrient cycling.
- 512. FOREST GENETICS (3) Qualitative and quantitative genetic principles and research methods applied in tree breeding.
- 517. FOREST MICROCLIMATOLOGY (3) A quantitative treatment of climate near the ground, with special reference to the role of forests and terrain. Prerequisite: PHYS 202.
- 518. HYDROLOGIC MEASUREMENTS (2) Selection, installation, use, and maintenance of instrumentation used in hydrologic research and watershed management. Prerequisites: FOR 470; FOR 519 or 3 credits in hydrology.

519. FOREST HYDROLOGY (3) Influence of forest cover on the disposition of precipitation and the application of hydrologic principles and techniques to forest watersheds. Prerequisites: FOR 308, CE 351.
520. SNOW HYDROLOGY (2) Role of snow and ice in the hydrologic cycle, with special emphasis on effects of forests and land use. Prerequisite: FOR 470 or 3 credits of hydrology.
521. ADVANCED SILVICULTURE (3) Specific silvicultural practices for the establishment and manipulation of forest stands with respect to recent developments and research needs. Prerequisite: FOR 421.
530. (W F S) CONSERVATION BIOLOGY (3) The application of biological principles to the conservation of biological diversity. Students who have passed FOR 430 may not schedule this course.
550. MULTIVARIATE ANALYSIS IN FORESTRY RESEARCH (3) Analysis and interpretation of research data involving several response variables. Includes computational considerations for large data sets.
555. MULTISPECTRAL REMOTE SENSING (3) Computer analysis of data from nonimaging remote sensors as applied to mapping of natural resources and land use. Prerequisite: FOR 455.
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)
- See also* Wildlife and Fisheries Science.

WOOD PRODUCTS (W P)

401. WOOD PRODUCTS AND PROCESSING (4)
411. WOOD-ENVIRONMENTAL RELATIONSHIPS (3)
412. WOOD IN STRUCTURES (3)
413. THE CHEMISTRY OF WOOD (3)
417. WOOD PRODUCTS MANUFACTURING SYSTEMS AND PROCESSES (4)
418. CHEMICAL PROCESSING OF WOOD (4)
423. DETERIORATION AND PROTECTION OF WOOD PRODUCTS (2)
435. WOOD PRODUCTS PRODUCTION AND SALES MANAGEMENT (3)
- 437W. WOOD INDUSTRIES MARKETING MANAGEMENT (4)
460. WOOD PRODUCTS INDUSTRIAL ENVIRONMENTAL CONTROL (3)
490. WOOD PRODUCTS COLLOQUIUM (1)
495. WOOD PRODUCTS INTERNSHIP (1-6)
496. INDEPENDENT STUDIES (1-18)
497. SPECIAL TOPICS (1-9)
502. WOOD FIBERS (3) Identification and measurement of physical and chemical characteristics of wood fibers used in paper or dissolving pulps.
511. PHYSICAL PROPERTIES OF WOOD AND FIBERS (3) Theories of moisture, diffusion, permeability, and heat transport; ultrastructure and thermal properties of wood and fibers. Prerequisite: W P 411.
513. WOOD CHEMISTRY (3) Treatment of the chemical components of wood, their distribution and reactions. Prerequisite: W P 413.
515. WOOD COMPOSITE PROCESSING PARAMETERS (3) Wood composite manufacture in theory and practice including various synthesis parameters in relation to physical and mechanical properties. Prerequisite: F P 415.
530. CASE STUDIES IN FOREST PRODUCTS (3) Manufacturing, marketing, and management issue analysis from a global perspective in the forest products industries.
531. MECHANICAL BEHAVIOR OF WOOD (3) Time-dependent properties, theory of failure, rheologic properties, and theory of the mechanical behavior of wood and structural composites.
532. THEORY OF ADHESION (3) Theory of adhesion as it pertains to bonding of wood, paper-based laminates, fibers, and bonding of wood to dissimilar materials.
537. INTERNATIONAL WOOD PRODUCTS MARKETING AND TRADE (3) Strategic analysis, environmental scanning, international trade policy implications, determinants of competitive strategy for firms, industries, and nations. Prerequisite: W P 437W.
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

FRENCH (FR)

JEANNETTE D. BRAGGER, *Head of the Department*
325 South Burrowes Building
814-865-1492

Degrees Conferred: Ph.D., M.A.

The Graduate Faculty

John H. Angell, Ph.D. (Ohio State) *Assistant Professor of French*
Jeannette D. Bragger, Ph.D. (California, Santa Barbara) *Professor of French*
Barbara Bullock, Ph.D. (Delaware) *Associate Professor of French and Linguistics*
Christine Clark-Evans, Ph.D. (Bryn Mawr) *Associate Professor of French and Women's Studies*
Wendy N. Greenberg, Ph.D. (Columbia) *Associate Professor of French*
Kathryn M. Grossman, Ph.D. (Yale) *Professor of French*
Thomas A. Hale, Ph.D. (Rochester) *Professor of African, French, and Comparative Literature*
Rebecca R. Kline, Ph.D. (Penn State) *Adjunct Assistant Professor of French*
Norris J. Lacy, Ph.D. (Indiana) *Edwin Erle Sparks Professor of French*
Christiane P. Makward, Docteur es Lettres (Sorbonne) *Professor of French*
Vera Mark, Ph.D. (Texas, Austin) *Assistant Professor of French*
Benedicte Monicat, Ph.D. (Maryland) *Associate Professor of French and Women's Studies*
Lisa Reed-Authier, Ph.D. (Universite d'Ottawa) *Assistant Professor of French Linguistics*
Willa Z. Silverman, Ph.D. (New York) *Associate Professor of French*
Julia Simon, Ph.D. (California, San Diego) *Associate Professor of French*
Allan Stoekl, Ph.D. (SUNY, Buffalo) *Professor of French and Comparative Literature*
Jean-Claude Vuillemin, Ph.D. (Michigan State) *Associate Professor of French*
Monique Yaari, Ph.D. (Cincinnati) *Associate Professor of French*

This program offers training in French literature, linguistics, and civilization in foreign language acquisition theory/pedagogy.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are highly recommended. Applicants for Graduate School fellowships are required to submit GRE verbal, quantitative, and analytical test scores, or other accepted test scores approved by the dean of the Graduate School. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

a speech sample in French or English of all applicants (in French or anglophones and speakers of other foreign languages, in English for francophones). This three- to five-minute tape recording (a C-30 cassette) should demonstrate the applicant's ability to speak extemporaneously and coherently about his/her study and career goals. In addition, a written text must be submitted (in French for anglophone and speakers of other foreign languages and in English for francophones) on a literary or cultural topic. M.A. candidates should submit a five-page senior-level paper from a literature or civilization course. Ph.D. candidates should submit a two- to three-page statement dealing with their specific research interests within a proposed concentration (civilization, foreign language acquisition and pedagogy, linguistics, literature). An M.A. paper or thesis could also be appended. Both the oral and the written samples must accompany the application. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.20 grade-point average may be made for students with special backgrounds, abilities, and interests.

Master's Degree Requirements

A candidate for the M.A. degree (minimum of 33 credits) may select a program of study emphasizing language proficiency as well as culture and literature. A reading knowledge of a second foreign language plus oral and written examinations are required. The candidate may submit either a thesis, for which 6 research credits are normally awarded, or a paper. The M.A. degree (or equivalent) is normally a prerequisite to doctoral candidacy.

Doctoral Degree Requirements

The Ph.D. degree prepares candidates for careers in teaching and research at the college or university level. A minimum of 43 credits beyond the M.A. in French (or equivalent) is required in graduate course work.

Credits must be distributed in any one of four areas of concentration: civilization, linguistics, literature, or second-language acquisition/pedagogy. Doctoral candidates must demonstrate either a four-skill proficiency, at the FS II level, in a second foreign language, or a reading knowledge of two foreign languages other than French equivalent to the 12-credit level. All doctoral students must pass a candidacy examination and a comprehensive written and oral examination.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

FRENCH (FR)

*121G. FUNDAMENTALS OF READING FRENCH (3) Instruction in fundamental skills required for reading expository French prose; primarily for research purposes. (This course may not be used to satisfy any baccalaureate degree requirements.) Prerequisite: senior- or graduate-standing.

*122G. PRACTICE IN READING FRENCH (3) Development and reinforcement of basic reading skills, with emphasis on the individual student's area of research. (This course may not be used to satisfy any baccalaureate degree requirements.) Prerequisite: FR 121G.

500. HISTORY OF THE FRENCH LANGUAGE (3) Evolution of French from its origin to the present day, with emphasis on Old French philology.

502. INTRODUCTION TO FRENCH LINGUISTICS (3) An overview of the major subfields of linguistics as they apply to the French language.

503. FRENCH PHONOLOGY (3) A theoretical approach to the sound structure of French. Prerequisite: FR 502.

504. FRENCH SYNTAX (3) An in-depth study of sentence structure in the French language. Prerequisite: FR 502.

505. SEMANTICS OF FRENCH (3) An in-depth study of how meaning is computed based on French data. Prerequisite: FR 502.

508. FRENCH BUSINESS COMMUNICATIONS (3 per semester, maximum of 6) Written and oral elements of French commerce and industry. Prerequisite: FR 510.

510. STYLISTIQUE AVANCÉE (3) Study of theoretical figures and expository style in prose and poetry through *dissertation* and *explication*.

511. READINGS IN OLD FRENCH (3 per semester, maximum of 6) A survey of French literature to 1300, focusing in alternate semesters on either the twelfth or the thirteenth century.

518. MEDIEVAL FRENCH DRAMA (3) The development of French drama from its liturgical origins to the flourishing comic theatre of the late Middle Ages.

526. AGE OF RABELAIS (3) Notions of literary creativity in the context of early sixteenth-century French Humanism; readings from Rabelais, Marguerite de Navarre, Scève.

528. AGE OF MONTAIGNE (3) Literary culture of Renaissance France in the context of social and political crisis; reading from Montaigne, DuBellay, Ronsard, and Sponde.

529. SEMINAR IN RENAISSANCE LITERATURE (3 per semester, maximum of 6) Intensive study of various French Renaissance writers in relation to selected artistic issues of the period.

530. LA FRANCE CONTEMPORAINE (3) A comprehensive cross-sectional view of French society and its institutions since World War II.

531. FRANCOPHONE CULTURE (3 per semester, maximum of 6) Concept of francophone; French minorities in Europe and North America; role of French language in Africa, Middle East, Far East.

532. FRENCH REGIONS AND REGIONALISMS (3) Interdisciplinary perspectives on the culture, history, and geography of the French regions and their regionalist identity movements.

533. BAROQUE AESTHETICS IN SEVENTEENTH-CENTURY FRENCH LITERATURE (3) Based on the Foucauldian notion of episteme, the course analyzes major seventeenth-century prose and poetry texts.

534. MOLIÈRE (3) The literary achievement of Molière, the comic playwright, director, actor, and founder of the Comédie Française.

535. TEXT AND PERFORMANCE: SEMIOTIC APPROACH TO FRENCH THEATRE (3) Based upon current theories and intellectual history, the course focuses on prolegomena of drama from the seventeenth century to the present.

540. VOLTAIRE AND HIS CONTEMPORARIES (3) The artistic and philosophical evolution of Voltaire as seen in the tragedy, the philosophical tale, and poetry.

*No graduate credit is given for this course.

541. ROUSSEAU AND HIS CONTEMPORARIES (3) Rousseau's rationalistic critique of civilization; his sentimental rehabilitation of the individual, family, state; Rousseau, precursor of romanticism.
543. SEMINAR: STUDIES IN THE ENLIGHTENMENT (3 per semester, maximum of 6) Discourse and thematic analysis of selected works of French Enlightenment genres: essay, drama, fiction, poetry.
545. ANALYSIS OF FRENCH CIVILIZATION (3-6) French cultural aspects, other than language and literature, conducted in French with the collaboration of specialists outside the French department.
547. MODERNISM AND POSTMODERNISM (3-6) Interdisciplinary approaches to these concepts, with a focus on artistic and literary objects in the French context. Prerequisite: FR 545, 571, or 580.
558. AFRICAN NOVEL IN FRENCH (3) Development of the novel in French from colonial era to independence; Africanization of genre with African verbal art forms.
559. ISSUES IN FRANCOPHONE LITERATURES (3) Diversity issues in Francophone literatures explored through various literary genres; variable focus may combine genre and topic.
562. FRENCH ROMANTICISM AND REALISM (3) Romanticism, realism, and their variations in the context of social and political revolution.
564. FIGURES OF ALTERITY IN NINETEENTH-CENTURY FRENCH LITERATURE (3) Representations of otherness in nineteenth-century French literature examined through race, gender, religion, and class paradigms.
565. SEMINAR: NINETEENTH-CENTURY STUDIES (1-6) Various nineteenth-century French writers considered in relation to selected esthetic and cultural problems raised during the period.
566. WOMEN WRITERS IN NINETEENTH-CENTURY FRANCE (3) Women's literary production in nineteenth-century France, including novels, poetry, travel narratives, children's literature, and essays.
569. MASTERS OF TWENTIETH-CENTURY FRENCH LITERATURE (3-6) Major literary figures of contemporary French literature.
570. MODERN FRENCH POETRY (3 per semester, maximum of 6) Historical overview through readings from major poets since Baudelaire; introduction to basic concepts in criticism of poetry.
571. FRENCH LITERARY CRITICISM FROM SAINTE-BEUVE TO PRESENT (3) Evolution of French literary criticism from Sainte-Beuve, the "father" of modern literary criticism, to contemporary critics.
572. SEMINAR: TWENTIETH-CENTURY FRENCH LITERATURE (3 per semester, maximum of 6) Specialized consideration of contemporary writers; for advanced students.
574. FRENCH FOLKLORE AND POPULAR CULTURE (3) Historical survey of French folklore and popular culture, with an emphasis on the modern period.
580. APPROACHES TO FRENCH CIVILIZATION (3) French interdisciplinary methods of cultural analysis and cultural history, with applications to French cultural artifacts.
581. THEORY AND TECHNIQUES OF TEACHING FRENCH (1-6)
583. READING AND FOREIGN LANGUAGE ACQUISITION: RESEARCH AND PRACTICE (3) Approaches to the study and teaching of reading in university departments of French; materials development practicum.
584. TESTING FRENCH AS A FOREIGN LANGUAGE: RESEARCH AND PRACTICE (3) Theoretical and practical approaches to problems in the testing of undergraduate French as a foreign language.
585. THE CURRICULUM IN PEDAGOGY AND ACQUISITION OF FRENCH AS A FOREIGN LANGUAGE (3) Approaches to the study and development of the undergraduate curriculum of French as a foreign language.
586. RESEARCH METHODS AND BIBLIOGRAPHY IN FRENCH CIVILIZATION (1) Introduction to research resources and skills in interdisciplinary French cultural studies and specific subfields of French and francophone culture/civilization.
587. RESEARCH TECHNIQUES AND BIBLIOGRAPHY IN FRENCH LANGUAGE AND LITERATURE (1-3)
589. (CMLIT, GER, SPAN) TECHNOLOGY IN FOREIGN LANGUAGE EDUCATION: AN OVERVIEW (3) Approaches to the uses and research applications of multimedia and other educational technologies applied to the teaching of foreign language.
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

FUEL SCIENCE (F SC)

Please note: Fuel Science is currently an option in the Department of Materials Science and Engineering and scheduled to become a degree program in the Department of Mineral Engineering in fall 1999 (see Department of Materials Sciences and Engineering).

GENETICS (GENET)

GUY F. BARBATO, *Chair, Intercollege Graduate Program in Genetics*
226 Henning Building
814-865-5202

Degrees Conferred: Ph.D., M.S.

The Graduate Faculty

Susan M. Abmayr, Ph.D. (Rockefeller) *Assistant Professor of Molecular Genetics*
Frank M. Ahern, Ph.D. (Hawaii) *Senior Research Scientist, Biobehavioral Health*
John E. Ayers, Ph.D. (Penn State) *Professor of Plant Pathology*
Paul Babitzke, Ph.D. (Georgia) *Assistant Professor of Biochemistry and Molecular Biology*
Guy F. Barbato, Ph.D. (Virginia Tech) *Associate Professor of Poultry Science*
David Blizard, Ph.D. (Wales) *Senior Research Scientist, Center for Development and Health Genetics*
Robert H. Bonneau, Ph.D. (Penn State College of Medicine) *Assistant Professor of Microbiology and Immunology*
Jean Brechley, Ph.D. (California, Davis) *Professor of Microbiology and Biotechnology*
Keith Cheng, M.D. (NYU School of Medicine); Ph.D. (Washington, Seattle) *Assistant Professor of Pathology; Adjunct Assistant Professor of Biochemistry and Molecular Biology*
Michael J. Chorney, Ph.D. (Cornell) *Assistant Professor of Microbiology and Immunology*
Barbara J. Christ, Ph.D. (British Columbia) *Associate Professor of Plant Pathology*
Andrew G. Clark, Ph.D. (Stanford) *Professor of Biology*
Pamela Correll, Ph.D. (George Washington) *Assistant Professor of Veterinary Science*
Diana Cox-Foster, Ph.D. (Illinois, Urbana-Champaign) *Assistant Professor of Entomology*
Richard Craig, Ph.D. (Penn State) *J. Franklin Styer Professor of Horticultural Botany; Professor of Plant Breeding*
Kristin Eckert, Ph.D. (Wisconsin, Madison) *Assistant Professor of Pathology*
Robert B. Eckhardt, Ph.D. (Michigan) *Professor of Developmental Genetics and Evolutionary Morphology*
Frederick G. Ferguson, D.V.M. (Oklahoma); Ph.D. (Pennsylvania) *Professor of Veterinary Science*
James G. Ferry, Ph.D. (Illinois) *Professor of Biochemistry and Molecular Biology*
Michael G. Fried, Ph.D. (Yale) *Associate Professor of Biochemistry and Molecular Biology*
Majid R. Foolad, Ph.D. (California, Davis) *Assistant Professor of Plant Genetics*
Glenn S. Gerhard, M.D. (Penn State) *Assistant Professor of Pathology*
Henry D. Gerhold, Ph.D. (Yale) *Professor of Forest Genetics*
David S. Gilmore, Ph.D. (Cornell) *Assistant Professor of Biochemistry and Molecular Biology*
Paul Grun, Ph.D. (Cornell) *Professor Emeritus of Cytogenetics*
Mark J. Guiltinan, Ph.D. (California, Irvine) *Assistant Professor of Plant Molecular Biology*
Ross C. Hardison, Ph.D. (Iowa) *Professor of Biochemistry*
George L. Hargrove, Ph.D. (North Carolina State) *Professor of Dairy Science*
Henry Harpending, Ph.D. (Harvard) *Professor of Anthropology*
S. Blair Hedges, Ph.D. (Maryland) *Assistant Professor of Biology*
Charles W. Hill, Ph.D. (Wisconsin) *Professor of Biochemistry and Molecular Biology*
Anita K. Hopper, Ph.D. (Illinois, Urbana-Champaign) *Professor of Biochemistry and Molecular Biology*
James E. Hopper, Ph.D. (Wisconsin) *Professor of Biochemistry and Molecular Biology*
Austin Hughes, Ph.D. (Indiana) *Assistant Professor of Biology*
Melvin W. Johnson, Ph.D. (Wisconsin) *Associate Professor of Plant Breeding*
Byron C. Jones, Ph.D. (Arizona) *Professor of Biobehavioral Health and Pharmacology*
Seogchan Kang, Ph.D. (Univ. of Wisconsin) *Assistant Professor of Plant Pathology*
Ralph L. Keil, Ph.D. (Cornell) *Assistant Professor of Biochemistry and Molecular Biology*
Zhi-Chun Lai, Ph.D. (Albert Einstein College of Medicine) *Assistant Professor of Biology*
C. Max Lang, D.V.M. (Illinois, Urbana-Champaign) *George T. Harrell Professor of Comparative Medicine*
Andrea M. Mastro, Ph.D. (Penn State) *Professor of Microbiology and Cell Biology*
William J. McCarthy, Ph.D. (NYU) *Associate Professor of Biochemistry of Biological Pesticides*
Gerald E. McClearn, Ph.D. (Wisconsin) *Evan Pugh Professor of Health and Human Development*
Patricia McLaughlin, D.Ed. (Penn State) *Assistant Professor of Neuroscience/Anatomy*
Bruce A. McPherson, Ph.D. (Illinois, Urbana-Champaign) *Assistant Professor of Entomology*

GENETICS

Karen J. Miller, Ph.D. (Massachusetts, Amherst) *Associate Professor of Food Microbiology*
Masatoshi Nei, Ph.D. (Kyoto, Japan) *Distinguished Professor of Biology*
B. Tracy Nixon, Ph.D. (MIT) *Associate Professor of Biochemistry and Molecular Biology*
Richard W. Ordway, Ph.D. (U Mass Medical School) *Assistant Professor of Biology*
Gary Perdew, Ph.D. (Oregon State) *Associate Professor of Veterinary Science*
Allen T. Phillips, Ph.D. (Michigan State) *Professor of Biochemistry*
C. Channa Reddy, Ph.D. (Indian Inst. of Science) *Distinguished Professor of Veterinary Science*
Charles P. Romaine, Ph.D. (Cornell) *Associate Professor of Plant Pathology*
Daniel J. Royse, Ph.D. (Illinois) *Professor of Plant Pathology*
Stephen W. Schaeffer, Ph.D. (Georgia) *Assistant Professor of Biology*
Esther Siegfried, Ph.D. (Washington, St. Louis) *Assistant Professor of Biology, and Biochemistry and Molecular Biology*
Lorraine M. Sordillo, Ph.D. (Louisiana State) *Assistant Professor of Veterinary Science*
David J. Spector, Ph.D. (Pennsylvania) *Associate Professor of Microbiology and Immunology*
Mark Stoneking, Ph.D. (California, Berkeley) *Assistant Professor of Anthropology*
Mary J. Tevethia, Ph.D. (Michigan State) *Professor of Microbiology and Immunology*
Graham H. Thomas, Ph.D. (Edinburgh, Scotland) *Assistant Professor of Biology, and Biochemistry and Molecular Biology*
Ming Tien, Ph.D. (Michigan State) *Professor of Biochemistry*
Chen-Pei David Tu, Ph.D. (Cornell) *Professor of Biochemistry and Molecular Biology*
Michael F. Verderame, Ph.D. (Columbia) *Assistant Professor of Medicine, Dept. of Medicine, Division of Endocrinology, Biabetes, and Metabolism*
Kenneth M. Weiss, Ph.D. (Michigan) *Professor of Anthropology*
Thomas A. Whittam, Ph.D. (Arizona) *Associate Professor of Biology*
Richard A. Wilson, Ph.D. (Montana State) *Professor of Veterinary Science*
Donald M. Wojchowski, Ph.D. (Massachusetts at Amherst) *Associate Professor of Cell Biology and Pathobiology*
Jerry L. Workman, Ph.D. (Michigan) *Assistant Professor of Biochemistry and Molecular Biology*
Ian S. Zagon, Ph.D. (Colorado) *Professor of Neuroscience and Anatomy*

The intercollege program in Genetics includes faculty from departments in the Colleges of Agricultural Sciences, Health and Human Development, the Liberal Arts, Medicine, and Science. Each student becomes associated with the adviser's department, which may provide financial support, research facilities, and office space. Applicants are encouraged to explore opportunities by contacting faculty who may be prospective advisers.

Fields available for study and research include molecular, biochemical, physiological, cellular, behavioral, developmental, pharmacological, population, and evolutionary genetics; also applications in recombinant DNA technology, genetic engineering, breeding plants or animals, and genetic counseling of humans. Organisms that are subjects of research include viruses, bacteria, fungi, insects, fish, birds, rodents, trees, agricultural plants, domestic animals, and humans. Many types of modern equipment, laboratories, field installations, and collections of various organisms are available.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are required for admission. Only under exceptional circumstances will an applicant be considered without these scores. In addition, applicants should have a cumulative undergraduate grade-point average of at least 3.00 and appropriate courses in biology (including genetics, organic chemistry or biochemistry), statistics, other sciences, and communications. The application must include three letters of reference and a statement describing and explaining interests in genetics, types of organism and research preferred, and goals during and after graduate studies.

All application materials should be submitted by January 31 for the best chance of admission and financial aid. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Master's Degree Requirements

A committee appointed for each student, with the approval of the program chair, determines specific courses, communication skills, and research acceptable for satisfying M.S. degree requirements. Students must meet the M.S. degree requirements specified by the Graduate School in the *Graduate Bulletin*. In addition, specific genetics course requirements include 12 credits selected from a list of approved genetics courses, 3 credits in statistics, and 2 credits per year in genetics colloquium. A thesis is required of all candidates for the M.S. degree.

Doctoral Degree Requirements

The student's Ph.D. committee, appointed after a written and oral candidacy examination is passed, determines specific requirements for courses and research, and administers the comprehensive and final examinations. The Graduate School requires no specified number of credits for the attainment of the doctorate. However, the Genetics program requires 15 credits in approved genetics courses, 3 credits in statistics, and 2 credits per year in genetics colloquium. The requirement in communication and foreign language skills is the same as that of the thesis adviser's department or program. All Ph.D. students are required to prepare and formally defend a thesis involving independent research.

A Ph.D. minor in genetics requires 12 credits in genetics course, plus 3 credits in statistics and 2 credits of genetics colloquium.

Other Relevant Information

When an applicant has been approved for admission by the faculty, an advisor is selected from those who indicate they are available, by mutual consent of the faculty member and the student; financial support is commonly a consideration at this time. The advisor is the chief source of guidance, advice, and liaison with the Genetics program and the associated department.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*. In most participating departments, Genetics applicants are eligible for departmental teaching or research assistantships, and other assistantships supported by grant funds of individual faculty who make these award decisions.

Applicants with a grade-point average above 3.60 and superior GRE scores are encouraged to request fellowship applications from the Graduate School before January 31.

GENETICS (GENET)

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

GEOGRAPHY (GEOG)

ROGER M. DOWNS, *Head of the Department*

302 Walker Building

814-865-3433

Degrees Conferred: Ph.D., M.S.

The Graduate Faculty

Ronald F. Abler, Ph.D. (Minnesota) *Professor Emeritus of Geography*

Todd Bacastow, Ph.D. (Penn State) *Adjunct Assistant Professor of Geography*

Cynthia A. Brewer, Ph.D. (Michigan State) *Associate Professor of Geography*

Andrew M. Carleton, Ph.D. (Colorado) *Professor of Geography*

Robert G. Crane, Ph.D. (Colorado) *Associate Dean and Professor of Geography*

David DiBiase, M.S. (Wisconsin) *Director, Deasy GeoGraphics Laboratory*

Lorraine Dowler, Ph.D. (Syracuse) *Assistant Professor of Geography*

Roger M. Downs, Ph.D. (Bristol) *Professor of Geography*

William Easterling, Ph.D. (North Carolina) *Associate Professor of Geography*

Rodney A. Erickson, Ph.D. (Washington) *Vice President for Research, Dean of the Graduate School*

Colin Flint, Ph.D. (Colorado) *Assistant Professor of Geography*

Susan W. Friedman, Ph.D. (Toronto) *Adjunct Assistant Professor of Geography*

Mark Gahegan, Ph.D. (Curtin) *Associate Professor of Geography*

Amy K. Glasmeier, Ph.D. (California, Berkeley) *Professor of Geography*

Peter R. Gould, Ph.D. (Northwestern) *Professor Emeritus of Geography*

Deryck W. Holdsworth, Ph.D. (British Columbia) *Professor of Geography*

G. Gregory Knight, Ph.D. (Minnesota) *Professor of Geography*

David Lindahl, Ph.D. (Washington) *Assistant Professor of Geography*

Peirce F. Lewis, Ph.D. (Michigan) *Professor Emeritus of Geography*

GEOGRAPHY

Alan M. MacEachren, Ph.D. (Kansas) *Professor of Geography*
Stephen Matthews, Ph.D. (U of Wales) *Adjunct Assistant Professor of Geography*
E. Willard Miller, Ph.D. (Ohio State) *Professor Emeritus of Geography*
Donna J. Peuquet, Ph.D. (SUNY, Buffalo) *Professor of Geography*
Allan L. Rodgers, Ph.D. (Wisconsin) *Professor Emeritus of Geography*
Adam Rome, Ph.D. (Kansas) *Assistant Professor of Geography; Assistant Professor of History*
Paul D. Simkins, Ph.D. (Wisconsin) *Professor Emeritus of Geography*
Andrew Sluyter, Ph.D. (Texas) *Assistant Professor of Geography*
Marieta P. Staneva, Ph.D. (Sofia) *Adjunct Assistant Professor of Geography*
Alan H. Taylor, Ph.D. (Colorado) *Associate Professor of Geography*
Christopher Uhl, Ph.D. (Michigan) *Adjunct Professor of Geography*
Frederick L. Wernstedt, Ph.D. (UCLA) *Professor Emeritus of Geography*
Anthony V. Williams, Ph.D. (Michigan State) *Professor Emeritus of Geography*
Lakshman S. Yapa, Ph.D. (Syracuse) *Associate Professor of Geography*
Brenton M. Yarnal, Ph.D. (Simon Fraser) *Professor of Geography*
Wilbur Zelinsky, Ph.D. (California, Berkeley) *Professor Emeritus of Geography*

The faculty encourages graduate students to arrange courses of study appropriate to their individual needs and aspirations. Programs in Geography may be directed toward a career in public service, teaching and research, private industry, or one of the many other vocational opportunities open to geographers.

Students may concentrate their study on topics that fall within the special skills and interests of the faculty. Current specialties include behavioral geography; biogeography; cartography; climatology; cultural geography; feminist geography; geographic education; geographic information science; geography of the developing world; geographic theory; geographic visualization; historical geography; nature and society; political geography; population geography; regional economic development and industrial location; remote sensing; and urban geography.

The master's program is broadly based. It is designed to provide beginning graduate students with basic training in systematic fields, geographical theory, and research techniques. Study at the doctoral level is more specialized. After admission to candidacy, doctoral students select two fields of concentration. Students may specialize in the geography of a region only if one of the faculty on their doctoral committee has research experience in that region.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are required for admission. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Students with a 3.00 junior/senior average (on a 4.00 scale) and with appropriate course work in geography or a related discipline will be considered for admission to the M.S. program. Applicants with master's degrees from high-quality graduate programs in geography will be considered for admission to the doctoral program. The best-qualified applicants will be admitted up to the number of places that are available for new students. All students must have or must acquire competence in cartography and statistical analysis.

Baccalaureate students must earn a master's degree before they will be considered for admission to the doctoral program.

Master's Degree Requirements

The M.S. degree may be earned by completing a thesis or two papers. If the two-paper option is elected, the candidate must earn 35 credits of graduate-level work. The master's papers are usually expanded versions of course or semester papers that are of sufficiently high quality that they can be submitted to scholarly journals. At least one of the papers offered to fulfill the M.S. papers requirement must have been written in connection with a departmental course or seminar.

All M.S. students are required to enroll in GEOG 500 (Introduction to Geographic Research) during their first year of residence. All candidates for the M.S. must take and pass an oral qualifying examination administered by three members of the graduate faculty before completing the M.S.

Doctoral Degree Requirements

The Graduate School's communication and foreign language requirement for the Ph.D. degree shall be satisfied in a manner approved by the candidate's doctoral committee.

All doctoral students are required to enroll in GEOG 500 (Introduction to Geographic Research) during their first year of residence.

Other Relevant Information

Penn State's graduate program in Geography works with incoming students to design programs tailored to their specific interests and needs. Thus there are few formal requirements and a maximum of opportunities for students to pursue their own interests under the guidance of the faculty. Each student's work is supervised by his or her academic adviser and by a committee consisting of two additional members of the graduate faculty for M.S. students and three or four additional members for doctoral students.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

GEOGRAPHY (GEOG)

- 401W. HISTORICAL GEOGRAPHY OF NORTH AMERICA (3)
- 402. CULTURAL AND ANTHROPOGEOGRAPHY (3)
- 404M. THE AMERICAN SCENE: PART II (3)
- 405. GEOGRAPHY OF POPULATION (3)
- 406. HUMAN USE OF ENVIRONMENT (3)
- 407. (HIST 453) AMERICAN ENVIRONMENTAL HISTORY (3)
- 408W. HUMAN DIMENSIONS OF POTENTIAL GLOBAL WARMING (3)
- 413. BEHAVIORAL APPROACHES TO GEOGRAPHY (3)
- 415. GENDER AND GEOGRAPHY (3)
- 418. URBAN HISTORICAL GEOGRAPHY (3)
- 419. URBAN SOCIAL ISSUES, STRUCTURES, PROBLEMS, AND POLICIES (3)
- 420W. METROPOLITAN ANALYSIS (3)
- 421W. DYNAMIC CARTOGRAPHIC REPRESENTATION (3)
- 422. APPLIED CARTOGRAPHIC DESIGN (3)
- 425. CARTOGRAPHIC INFORMATION SYSTEMS (3)
- 427. GEOGRAPHY OF THE SOVIET UNION (3)
- 432W. CLIMATIC CHANGE AND VARIABILITY (3)
- 433W. INTRODUCTION TO GLOBAL CLIMATIC SYSTEMS (3)
- 434. REGIONAL PHYSIOGRAPHY (3)
- 435. FOREST GEOGRAPHY (3)
- 435W. FOREST GEOGRAPHY (3)
- 437. SATELLITE CLIMATOLOGY (3)
- 440W. MEXICO (3)
- 442. REGIONAL SYSTEMS IN EUROPE (3)
- 443. GEOGRAPHY OF THE ORIENT (3)
- 444. AFRICAN RESOURCES AND DEVELOPMENT (3)
- 450. DEVELOPMENT OF GEOGRAPHIC THOUGHT (3)
- 453. INTRODUCTION TO FIELD GEOGRAPHY (3)
- 454. SPATIAL ANALYSIS I (3)
- 455. SPATIAL ANALYSIS II (3)
- 458. GIS PRACTICUM (3)
- 459. DIGITAL TERRAIN MODELS (3)
- 460. POLITICAL GEOGRAPHY (3)
- 470. GEOGRAPHY OF THE GLOBAL ECONOMY (3)
- 480. SPATIAL DATA STRUCTURES AND ALGORITHMS (3)
- 481. GEOGRAPHIC INFORMATION SYSTEMS DESIGN AND EVALUATION (3)
- 495. INTERNSHIP (1-13)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
- 500. INTRODUCTION TO GEOGRAPHIC RESEARCH (1-3)
- 503. SEMINAR IN CLIMATOLOGY (3-6) Selected topics in climatology, emphasizing global-scale and man-climate interactions; individual and group projects. Prerequisite: GEOG 433W.
- 505. ECONOMIC GEOGRAPHY SEMINAR (3-12) The examination of current problems and theories in economic geography through critical discussion of the literature and original student research.
- 506. SEMINAR IN SOCIAL GEOGRAPHY (3) Graduate-level research seminar examining theory and methods in social geography.

GEOSCIENCES

507. HUMAN-ENVIRONMENT SEMINAR (3) Theory and method in human-environment interaction subfields; may be retaken when topics vary; readings, discussions, research.
508. CULTURAL GEOGRAPHY SEMINAR (3-12) The exploration of current problems and theory in cultural geography through critical discussion of the literature and original student research.
509. POPULATION GEOGRAPHY SEMINAR (3) Selected problems in population geography, with emphasis on analysis and presentation of data. Prerequisite: GEOG 405.
512. SEMINAR IN CARTOGRAPHY (3-6) The exploration of current problems and theory in cartography through critical discussion of the literature and original student research. Prerequisite: 6 credits in cartography.
515. (WMNST) GENDER AND GEOGRAPHY (3) Explanations of the links between gender relations and spatial structures.
518. GEOGRAPHIC PERSPECTIVES OF SPACE AND TIME (3) Examination of concepts and approaches for representing geographic space/spatial processes through critical discussion of literature and original student research.
520. SEMINAR IN URBAN GEOGRAPHY (3) Analysis of current literature in urban geography focusing on theoretical and methodological debates.
521. MAP SYMBOLIZATION AND DESIGN THEORY (3) Introduction to theoretical issues in map design and symbolization, with emphasis on current research trends and practical application of research. Students who have passed GEOG 421 may not schedule this course for credit. Prerequisites: GEOG 321, 454.
557. GEOGRAPHIC INFORMATION SYSTEMS (3) Principles and use of geographic information systems; emphasis is on practical use of GIS as a research methodology for geographic data handling and geographic analysis.
580. SPATIAL DATA STRUCTURES AND ALGORITHMS (3) In-depth examination of geographic information system components; representation and storage of spatial data, spatial algorithms, input-output considerations. Students who have passed GEOG 480 may not schedule this course for credit. Prerequisites: GEOG 456, 457.
581. GEOGRAPHIC INFORMATION SYSTEMS DESIGN AND EVALUATION (3) Graduate-level examination of Geographic Information System and other forms of integrated spatial data system design. Prerequisite: GEOG 580.
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

GEOSCIENCES (GEOSC)

RUDY L. SLINGERLAND, *Head of the Department of Geosciences*
LEE R. KUMP, *Associate Head for Graduate Program and Research*
EARL K. GRAHAM, *Associate Head for Undergraduate Programs*
303 Deike Building
814-865-6393

Degrees Conferred: Ph.D., M.S.

The Graduate Faculty

Shelton S. Alexander, Ph.D. (Cal. Tech.) *Professor of Geophysics*
Richard B. Alley, Ph.D. (Wisconsin, Madison) *Professor of Geosciences*
Michael A. Arthur, Ph.D. (Princeton) *Professor of Geosciences*
Hubert L. Barnes, Ph.D. (Columbia) *Distinguished Professor Emeritus of Geochemistry*
Eric J. Barron, Ph.D. (Miami) *Professor of Geosciences*
Susan L. Brantley, Ph.D. (Princeton) *Professor of Geosciences*
Douglas Burbank, Ph.D. (Dartmouth) *Professor of Geosciences*
Roger J. Cuffey, Ph.D. (Indiana) *Professor of Paleontology*
Alan Davis, Ph.D. (Durham) *Professor Emeritus of Geology*
Peter Deines, Ph.D. (Penn State) *Professor of Geochemistry*
David H. Eggler, Ph.D. (Colorado) *Professor of Petrology*
Terry Engelder, Ph.D. (Texas A&M) *Professor of Geosciences*
Donald M. Fisher, Ph.D. (Brown) *Associate Professor of Geosciences*
Peter B. Flemings, Ph.D. (Cornell) *Associate Professor of Geosciences*

Katherine H. Freeman, Ph.D. (Indiana) *Associate Professor of Geosciences*
 Kevin P. Furlong, Ph.D. (Utah) *Professor of Geosciences*
 David P. Gold, Ph.D. (McGill) *Professor Emeritus of Geology*
 Earl K. Graham, Ph.D. (Penn State) *Professor of Geophysics*
 Roy J. Greenfield, Ph.D. (MIT) *Professor of Geophysics*
 Peter Heaney, Ph. D. (Johns Hopkins) *Associate Professor of Geosciences*
 James F. Kasting, Ph.D. (Michigan) *Professor of Geosciences and Meteorology*
 Derrill M. Kerrick, Ph.D. (California, Berkeley) *Professor of Geochemistry*
 Lee R. Kump, Ph.D. (South Florida) *Professor of Geosciences*
 Charles A. Langston, Ph.D. (Cal. Tech.) *Professor of Geophysics*
 Raymond G. Najjar, Ph.D. (Princeton) *Assistant Professor of Meteorology*
 Hiroshi Ohmoto, Ph.D. (Princeton) *Professor of Geochemistry*
 Richard R. Parizek, Ph.D. (Illinois) *Professor of Geology*
 Mark E. Patzkowsky, Ph.D. (Chicago) *Assistant Professor of Geosciences*
 Arthur W. Rose, Ph.D. (Cal. Tech.) *Professor Emeritus of Geochemistry*
 Rustum Roy, Ph.D. (Penn State) *Professor of the Solid State*
 Rudy L. Slingerland, Ph.D. (Penn State) *Professor of Geology*
 Deane K. Smith, Ph.D. (Minnesota) *Professor Emeritus of Mineralogy*
 Todd A. Sowers, Ph.D. *Assistant Professor of Geosciences*
 Barry Voight, Ph.D. (Columbia) *Professor of Geology*
 William B. White, Ph.D. (Penn State) *Professor of Geochemistry*

The M.S. and Ph.D. programs in Geosciences provide students with a broad background in any of the major areas of geological sciences and intensive research experiences culminating in the preparation of a formal paper or thesis. The goal of the program is to prepare students for a variety of careers in academia, government, or industry.

A wide range of faculty interests and exceptional laboratory facilities afford many areas of specialization in which students may choose their course work and research topics. In addition to extensive computing and supercomputing facilities developed in association with the Earth System Science Center, students have access to a wealth of analytical, experimental, and field equipment. State-of-the-art analytical equipment is maintained by the department and the Materials Characterization Laboratory. The department has field facilities for study of hydrogeology and geochemistry of natural waters and a coastal marine laboratory at Wallops Island, Virginia. Remote sensing facilities exist in the Department of Geography and the Office for Remote Sensing of Environmental Resources. The department's Geodynamics Institute explores current problems in plate tectonics and the college's Energy Institute investigates the genesis and occurrence of fossil fuels. The department has close ties with the college's Environment Institute and its Earth System Science Center for research in global processes, and paleoclimatology, its Center for Environmental Chemistry and Geochemistry, and its Center for Research in Natural Hazards.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are normally required for admission. Exceptions must be approved by the department. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

For admission, applicants generally are expected to have a bachelor's degree in some branch of the natural or physical sciences, engineering, or mathematics. An applicant also is expected to have completed standard introductory courses in geosciences, chemistry, physics, and mathematics through integral calculus, plus 15 credits of intermediate-level work in one or a combination of these subjects. Greater than minimal preparation in chemistry, geology, biology, mathematics, or physics may be required for particular subdisciplines. Applicants who have taken somewhat less than the indicated minimum in these subjects may be admitted but must make up their deficiencies concurrently with their graduate studies. Students with special backgrounds, abilities, and interests whose undergraduate grade-point average in courses pertinent to geosciences is below a 3.00 (on a 4.00 scale) will be considered for admission only when there are strong indications that a 3.00 average can be maintained at the graduate level.

Students are admitted both to the M.S. and Ph.D. degree programs. A student may work toward a Ph.D. degree without first earning a master's degree. If this option is desired, the student must arrange the scheduling of a candidacy evaluation no later than the end of the third semester of residence at Penn State.

Faculty Advisers

Upon arrival students will be advised initially by a committee appointed by the associate head for Graduate Programs and Research. The committee in turn will designate an interim adviser. Before the end of the first

academic year of residence, the student is expected to develop specific academic and research interests so that an appropriate permanent academic adviser and research supervisor may be chosen. The academic adviser and research supervisor are usually the same person, except when the research supervisor is not a member of the geosciences department. In such a case, a Geosciences program faculty member serves as the academic adviser.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*. In addition, several graduate fellowships are available for students within the Department of Geosciences.

Programs of study are planned to require no more than two years for the M.S. degree and three additional years, or five years total, for the Ph.D. degree. A student transferring to the department with the M.S. degree should plan on four additional years. Financial support from teaching or research assistantships or from fellowships is available to students in good standing, but not awarded beyond these limits except in unusual cases.

Common Degree Requirements

All graduate students in Geosciences are expected to acquire breadth of knowledge in the geosciences, a fundamental and advanced knowledge of their subdiscipline, and skills in the areas of data collection and quantitative analysis. Toward that end, all graduate students must select one of the approved courses in each of the following areas:

- (1) Geosciences Breadth
- (2) Disciplinary Fundamentals
- (3) Data Gathering
- (4) Quantitative Analysis

A current list of approved courses is maintained by the department's Graduate Program Office in 303 Deike Building. The list may be modified by approval of the department's Graduate Program Committee.

Additional Master's Degree Requirements

As part of the M.S. program, each student is required to complete a thesis. The thesis must be defended in an oral examination administered by an M.S. committee.

Additional Doctoral Degree Requirements

Admission to Ph.D. candidacy is determined by an oral examination before a candidacy committee. Preparation and defense of two research proposals will serve as one means of assessing the student's ability. At least one of these proposals should represent original work by the student, but the other may be an actual thesis proposal and involve limited initial input from the adviser or others.

The comprehensive examination is both oral and written. It is administered by the doctoral committee after the student has essentially completed course work and after a foreign language requirement (if required by the committee) is fulfilled. A final oral defense of the thesis is required.

GEOSCIENCES (GEOSC)

- 402. NATURAL DISASTERS (3)
- 412. WATER RESOURCES GEOCHEMISTRY (3)
- 413. TECHNIQUES IN ENVIRONMENTAL GEOCHEMISTRY (3)
- 415. GEOCHEMISTRY (3)
- 416. STABLE AND RADIOACTIVE ISOTOPES IN GEOSCIENCES: INTRODUCTION (3)
- 418. SOIL ENVIRONMENTAL CHEMISTRY (4)
- 419. THE ORGANIC GEOCHEMISTRY OF NATURAL WATERS AND SEDIMENTS (3)
- 420. (BIOL) PALEOBOTANY (3)
- 421. INTRODUCTION TO COAL PETROLOGY (3)
- *422. COAL MEASURE GEOLOGY (3)
- 423. (BIOL) INTRODUCTORY PALYNOLOGY (4)
- 424. PALEONTOLOGY AND FOSSILS (3)
- 425. FOSSILS (3)
- 426. PALEOECOLOGY (3)
- 427. (BIOL) EVOLUTION (3)
- 430. PETROLOGY (5)

*This course includes from one to several field trips for which an additional charge will be made.

- 434. VOLCANOLOGY (3)
- *439. PRINCIPLES OF STRATIGRAPHY (3)
- 440. MARINE GEOLOGY (3)
- 445. COASTAL GEOLOGY (4)
- 451. ECONOMIC GEOLOGY (3)
- 452. INTRODUCTION TO HYDROGEOLOGY (3)
- 454. GEOLOGY OF OIL AND GAS (3)
- 457. APPLIED AND ENVIRONMENTAL GEOCHEMISTRY (3)
- 461. GEOLOGY OF NORTH AMERICA (3)
- *462. DRAINAGE BASIN ANALYSIS (3)
- 465. STRUCTURAL GEOLOGY (4)
- 466. MECHANICS OF GEOLOGICAL MATERIALS (3)
- *470W. INTRODUCTION TO FIELD GEOLOGY (3)
- *471. FIELD STUDIES IN NORTH AMERICA (3)
- *472. GEOSCIENCES SUMMER FIELD SCHOOL (6)
- 473. GEOPHYSICAL FIELD TRIP
- 479. ADVANCED STRATIGRAPHY
- 481. SOLID EARTH AND PLANETARY GEOPHYSICS
- 483. ENVIRONMENTAL GEOPHYSICS
- 484. GEOPHYSICAL SURVEYING (3)
- 487. ANALYSIS OF TIME SERIES (4)
- 489. DYNAMICS OF THE EARTH (4)
- 494W. SENIOR THESIS (1-9)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

501. FRONTIERS IN GEOSCIENCES (1) Current research problems and activities in the geosciences. Pass-fail grades are used for evaluation.

503. (MATSC) KINETICS OF MATERIALS PROCESSES (3) Introduction to application of transition state theory and mass transfer to the kinetics of materials and mineral processes. Prerequisites: MATH 250, CHEM 451; GEOSC 519 or MATSC 501.

504. ADVANCED GEOCHEMISTRY (3) A comprehensive treatment of the principles of geochemistry applied to a wide variety of geologic settings and scales. Prerequisite: CHEM 451.

505. QUANTITATIVE PHYSICAL SEDIMENTOLOGY (3) Principles of fluid mechanics and mathematical modeling; their use in describing sediment transport, sedimentary structure, and sedimentary environments. Prerequisite: GEOSC 330.

506. MATERIAL PROPERTIES AND THE CONSTITUTION OF EARTH (3) Application of the properties of materials to the composition and physical state of Earth's crust, mantle, and core.

507A. SEISMOLOGY (3) Basic theory; seismic methods for inferring structure of planetary interiors; observational techniques; seismic event location, magnitude, and damage potential.

507B. SEISMOLOGY (3) Advanced wave propagation theory; mathematical representation of seismic sources; inversion theory; computational methods.

508. TECTONICS (3) Seminar in the cause and nature of the principal deformations of the Earth.

509. (ECEEM) GEOLOGY AND ECONOMICS OF THE CONSTRUCTION MATERIALS (3) Occurrence, origin, and marketing of the mineral materials used by the construction industry. Economic and geologic evaluation of actual deposits.

510. (ECEEM 542) GEOLOGY AND ECONOMICS OF THE INDUSTRIAL MINERALS (3) Occurrence, origin, and marketing of the industrial minerals and evaluation of deposits. Chemical and ceramic raw materials emphasized.

511. (MATSC) INSTRUMENTAL TECHNIQUES APPLIED TO MATERIALS AND MINERAL SCIENCES PROBLEMS (1-7) See units A through G for description.

Unit A. (MATSC) POWDER X-RAY DIFFRACTION (1) Compound identification, lattice parameter measurement, and other applications of the powder diffraction method.

Unit B. (MATSC) TRANSMISSION ELECTRON MICROSCOPY (1) Principles and practice of transmission electron microscope operation. Students undertake individual projects.

Unit C. (MATSC) SPECTROSCOPY (1) Emission spectrographic analysis of powders and atomic absorption analysis of solutions.

Unit D. (MATSC) ELECTRON MICROPROBE ANALYSIS (1) Qualitative and quantitative elemental analysis of microvolumes within solids. Emphasis on individual student projects.

*This course includes from one to several field trips for which an additional charge will be made.

Unit E. (MATSC) SCANNING ELECTRON MICROSCOPY (1) Principles and practice of scanning electron microscope operation. Students undertake individual projects.

Unit G. (MATSC) ANALYTICAL ELECTRON MICROSCOPY (1) Modern analytical electron microscope techniques: scanning transmission electron microscopy; electron energy loss spectroscopy; energy dispersive analysis of X-rays. Prerequisite: MATSC (GEOSC) 511B.

512. (MATSC) PRINCIPLES OF CRYSTAL CHEMISTRY (3) Relation of structure to ionic size and nature; influence of pressure and temperature on structure; chemical-structural defects, crystalline solutions, phase-transitions.

513. (SOILS) SOIL PHYSICAL CHEMISTRY (3) Surface and colloid chemistry of soils including sorption processes and kinetics, dissolution reactions, particle interactions, and associated modeling techniques. Prerequisites: CHEM 451, SOILS 419.

515. ORE PETROLOGY (3) Optical and hardness measurements and phase equilibria as used in identification and interpretation of texture of ore minerals. Offered alternate years.

516. ADVANCED EXPLORATION GEOPHYSICS (2-6) Special topics and new developments in exploration geophysics; coverage (2 credits each) in gravity and magnetic, electrical, electromagnetic, or seismic methods.

518. STABLE ISOTOPE GEOCHEMISTRY (3) Theory of isotope fractionation mechanisms; its application to a wide range of problems in the Earth and planetary sciences.

519. MINERAL EQUILIBRIA (3) A thermodynamic treatment of minerals and their reactions under geochemically important conditions of temperature and pressure. Prerequisite: CHEM 451.

520. PHASE EQUILIBRIA (2-3) Thermodynamic and geometrical analysis of phase equilibria in oxide and mineral systems at atmospheric and elevated pressures.

521. THERMAL STATE OF THE EARTH (2-3) Analytical and numerical solutions to Earth-related heat conduction and convection problems; geothermal energy; Earth's heat flow and temperature.

522. GEOCHEMISTRY OF AQUEOUS SYSTEMS (2-3) Ionic and molecular equilibria related to stabilities and solubilities of minerals, with applications to ground water, sea water, and hydrothermal fluids. Prerequisites: CHEM 451, 452.

523. SEDIMENTARY GEOCHEMISTRY (2) Kinetics and thermodynamics of low-temperature processes in sediments. Applications to weathering processes, natural waters, deposition of sediments, and diagenesis. Prerequisites: GEOSC 430.

524. (MATSC) VIBRATIONAL SPECTRA OF MATERIALS AND MINERALS (3) Infrared and Raman spectroscopy of materials, with applications of mineralogy, geochemistry, ceramics, and glass research. Offered alternate years.

525. ELECTRONIC PROPERTIES OF MINERALS (3) Application of spectroscopy to mineralogy—crystal field, E.P.R., N.M.R., and Mossbauer spectral evidence of ordering, element distribution, and stabilities. Offered alternate years.

526. (BIOL) PROBLEMS IN PALYNOLOGY (1-6) Individual research projects in various aspects of palynology, especially palynostratigraphy and paleoecological palynology. Prerequisite: BIOL 423.

528. COAL PETROLOGY (1-6) Microscopy, source materials, coalification, constitution, classification of peats, lignites, bituminous coal, anthracite.

529. PALEONTOLOGY (1-6 per semester, maximum of 9) Morphology and distribution of significant fossil groups; sampling, preparation, and applications to biostratigraphy, evolution, paleoecology, sedimentation, and petrography.

530. TOPICS IN HYDROTHERMAL GEOCHEMISTRY (2) Methods of obtaining data; their evaluation and use in the quantitative treatment of hydrothermal systems, primarily by thermodynamic methods. Prerequisites: GEOSC 519, 522.

531. ORIGIN OF EARTH AND MOON (3) This course will be part lecture, part seminar; each student is required to prepare and present one of two lecture topics during the course of the semester.

535. (MATSC) GEOMETRICAL CRYSTALLOGRAPHY (3) Derivation of lattices, types, point groups, and space groups; and group theory applied to crystallography and spectroscopy. Offered alternate years.

540. ORE DEPOSITS I (3) Geochemistry and geology of ore deposits formed by igneous and high-temperature hydrothermal processes. Prerequisite: GEOSC 451.

541. ORE DEPOSITS II (3) Geochemistry and geology of ore deposits formed by low-temperature hydrothermal, sedimentary, metamorphic processes; continuation of GEOSC 540. Prerequisite: GEOSC 540.

542. QUANTITATIVE METHODS IN HYDROGEOLOGY (1-4) Investigation of groundwater systems and resources, emphasizing both the practical use and limitations of modeling techniques. Prerequisites: GEOSC 452.

543. ENVIRONMENTAL GEOLOGY (1-3) A multidisciplinary study of the impact of human-induced stress on the environment. Prerequisites: GEOSC 452.

545. GLACIAL GEOLOGY (3) Glaciers: their characteristics, causes, deposits, landforms, effects in periglacial regions.
546. PRINCIPLES OF PHOTOGEOLOGY (3) Use of aerial photographs and mosaics in structural, geomorphic, and rock distribution studies and in compilation of maps. Prerequisites: GEOSC 462, 465.
550. IGNEOUS AND METAMORPHIC PETROLOGY (4) Analysis of controls of mineralogy, elemental, and isotopic compositions of igneous rock series, and of metamorphic rocks. Prerequisite: GEOSC 430.
555. ADVANCED STRUCTURE AND PETROFABRICS (1-3) Macroscopic and mesoscopic recognition, measurement, and interpretation of small-scale rock structure and mineral orientation patterns in deformed rocks.
557. DYNAMIC STRUCTURAL GEOLOGY AND GEOTECTONICS (3-6) Phenomena of fracturing, faulting, folding; stress and (finite) strain analysis, physical and analytical models; deformational environments; tectogenesis and orogenesis.
560. KINETICS OF GEOLOGICAL PROCESSES (3) General development of the kinetic theory of crystal growth, diffusion, irreversible thermodynamics, and heterogeneous reactions needed for geosciences and related fields, with applications to current problems. Prerequisites: CHEM 451, GEOSC 519.
562. DRAINAGE BASIN EVOLUTION (4) General development of the theories governing the evolution of drainage basins with emphasis on tectonic and climatic perturbations and human impact. Prerequisite: introductory course in geomorphology.
565. TECTONIC GEOMORPHOLOGY (3) Tectonic geomorphology examines interactions between tectonic and surface processes, paleoseismology, geodesy, structure, active deformation, and landform evolution. Prerequisite: GEOSC 340, 465.
571. FIELD PROBLEMS IN APPALACHIAN GEOLOGY (2) Geologic history of the central Appalachians as deduced from field studies.
588. (METEO) OCEANS AND CLIMATE SEMINAR (2) A focused discussion on some aspect of the ocean's role in the climate system. Theme to vary from semester to semester.
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

GERMAN (GER)

GERALD F. STRASSER, *Head of the Department*
311 Burrowes Building
814-865-5481

Degree Conferred: Ph.D., M.A., M.Ed.

The Graduate Faculty

- Thomas O. Beebe, Ph.D. (Michigan) *Associate Professor of Comparative Literature and German*
- Julie Anne Belz, Ph.D. (California) *Assistant Professor of German*
- Barton W. Browning, Ph.D. (California) *Associate Professor of German*
- William G. Crisman, Ph.D. (California) *Associate Professor of English, Comparative Literature, and German*
- Juergen Eichhoff, Dr.Phil. (Universität Marburg) *Professor of German;*
- Edda S. Gentry, Dr.Phil. (Universität Marburg) *Senior Adjunct Lecturer in German*
- Francis G. Gentry, Ph.D. (Indiana) *Professor of German; Director, Max Kade German-American Research Institute*
- Michael Hager, Ph.D. (Freie Universität Berlin) *Assistant Professor of German*
- Manfred E. Keune, Ph.D. (Michigan State) *Associate Professor of German*
- B. Richard Page, Ph.D. (Wisconsin, Madison) *Assistant Professor of German*
- Marlene A. Pilarcik-Soulsby, Ph.D. (SUNY, Binghamton) *Associate Professor of German*
- Ernst I. Schürer, Ph.D. (Yale) *Professor of German*
- Gerhard F. Strasser, Ph.D. (Brown) *Professor of German and Comparative Literature*
- Markus Winkler, Dr.Phil. (Universität Bonn) *Professor of German*
- Vickie L. Ziegler, Ph.D. (Yale) *Associate Professor of German; Director, Center for Medieval Studies*

Programs of study with major emphasis upon literature, philology, culture, or the teaching of German lead to advanced degrees.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are desirable. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Minimum qualifications for admission include 30 undergraduate credits in German beyond the intermediate level. Provision is made, however, for admission with limited deficiencies. Students with a 3.00 junior/senior average (on a 4.00 scale) and with appropriate course backgrounds will be considered for admission. Requirements for admission to the M.Ed. degree program include 18 credits in education and related psychology. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

Master's Degree Requirements

Work for the master's degree can be completed in two semesters of full-time study or, if the student is a graduate assistant, in three to four semesters. The degree requires a substantial research paper, a written examination, and an oral examination. A minor is optional.

Course work in the M.A. program includes bibliography and research techniques, history of the German language, and seminars providing intensive study of selected authors or topics. Practical experience in supervised teaching is required for all graduate degrees.

In the M.Ed. program, the student may select courses in the history of the German language, linguistics, German culture and civilization, advanced German stylistics, and educational theory and policy in addition to courses in German literature. Appropriate courses taken in the College of Education can lead to certification for secondary schools in Pennsylvania. Requirements for admission to the M.Ed. degree program include 18 credits in education and related psychology.

Doctoral Degree Requirements

For the Ph.D., a student must complete at least 65 course credits (including M.A. credits) of graduate-level work. Students specialize in one of four tracks: Second-Language Acquisition; Linguistics; German Literature; or German Culture. GER 430, 500, 511, and 591 are required of all students. Other requirements include: (1) reading knowledge of one foreign language in addition to German and English, (2) comprehensive examination with written and oral components, and (3) doctoral dissertation.

Other Relevant Information

Penn State's Pattee Library maintains excellent holdings for research, including the Allison-Shelley Collection of Anglica, Americana, and Germanica; extensive collections of German Baroque literature on microfilm and of emblem books; and twentieth-century German literature, especially the works of German writers in exile since 1933. The Seminar Library in Burrowes Building serves the needs of students with reference works, German journals, newspapers, and an extensive textbook collection. The Max Kade German-American Research Institute supports research on the history and cultural heritage of German immigration to the United States. The Center for Medieval Studies fosters the growth and expansion of medieval studies at Penn State.

Student Aid

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AID section of the *Graduate Bulletin*, the following awards typically have been available to graduate students in this program:

EXCHANGE FELLOWSHIPS AT CHRISTIAN ALBRECHTS UNIVERSITÄT, KIEL, PHILLIPS UNIVERSITÄT, MARSBURG, AND THE BILDUNGSWISSENSCHAFTLICHE HOCHSCHULE, FLENSBURG—Available to graduate students in German and other fields for a full academic year. Students must have a good command of German. Stipend is approximately \$600 per month plus tuition. EDWIN ERLE SPARKS DISSERTATION FELLOWSHIP IN THE HUMANITIES—Available to a doctoral candidate in one of the following graduate programs: Comparative Literature, English, French, German, History, Linguistics, Philosophy, Spanish, and Speech Communication; stipend \$12,645 plus waiver of tuition. Apply to department before January 15.

EDWIN ERLE SPARKS FELLOWSHIPS IN THE HUMANITIES (8)—Available to beginning and continuing graduate students in one of the following graduate programs: Comparative Literature, English, French, German, History, Linguistics, Philosophy, Spanish, and Speech Communication; stipend \$9,060 plus waiver of tuition. Apply to department before January 15.

INTERDISCIPLINARY GRADUATE FELLOWSHIP for doctoral students for interdisciplinary course work to augment studies in German. Request information from Graduate Officer.

These fellowships include grants-in-aid covering all tuition charges. Advanced graduate students who do not hold fellowships or assistantships also may apply for graduate grants-in-aid that cover tuition charges.

Graduate assistantships require teaching, under supervision.

GERMAN (GER)

- 401. ADVANCED CONVERSATION AND COMPOSITION (3)
- 408. ADVANCED GERMAN BUSINESS COMMUNICATIONS (3)
- 411. THE TEACHING OF GERMAN (3)
- 412. CONTRASTIVE ANALYSIS OF MODERN GERMAN AND ENGLISH (3)
- 430. HISTORY OF THE GERMAN LANGUAGE (3)
- 440. SENIOR SEMINAR IN GERMAN CULTURE (3)
- 452. LITERATURE OF THE RENAISSANCE (3)
- 460. LITERATURE OF THE BAROQUE (3)
- 461. LITERATURE OF THE ENLIGHTENMENT (3)
- 462. LITERATURE OF THE LATE EIGHTEENTH CENTURY (3)
- 470. GOETHE (3)
- 471. SCHILLER (3)
- 472. ROMANTICISM (3)
- 480. REALISM (3)
- 481. EARLY TWENTIETH CENTURY (3)
- 482. GERMAN LITERATURE FROM 1933 TO THE PRESENT (3)
- 494. RESEARCH PROJECT (1–12)
- 495. INTERNSHIP (3–9)
- 496. INDEPENDENT STUDIES (1–18)
- 497. SPECIAL TOPICS (1–9)
- 499. FOREIGN STUDY—GERMAN (3–6) Advanced studies in German language, literature, and culture. Prerequisite: any 300-level course in German.
- *001G. ELEMENTARY GERMAN FOR GRADUATE STUDENTS (3) Designed for students preparing to satisfy language requirements for advanced degrees.
- *002G. ELEMENTARY GERMAN FOR GRADUATE STUDENTS (3) Continuation of GER 001G, with opportunity for reading in special fields.
- 500. BIBLIOGRAPHY AND RESEARCH TECHNIQUES (2) Introduction to tools and methods of research, designed for students preparing for independent investigation of problems in German literature and language.
- 501. GERMAN CONVERSATION AND COMPOSITION (1) Advanced study of German conversation and composition, with emphasis on syntax, style and idiomatic constructions.
- 508. GERMAN BUSINESS COMMUNICATIONS (3) Practices and problems in the administration of German business organizations. Writing letters, reports, and other types of business communications. Prerequisites: GER 308 and 408.
- 510. LITERARY THEORY AND ITS APPLICATIONS (2) Introduction to literary theory with particular emphasis on more recent models; critical examination of selected literary texts.
- 511. THE TEACHING OF COLLEGE GERMAN (2) Theory, methods, techniques, materials, bibliography, contributions of linguistics and psychology to language learning; methods of teaching post-secondary German.
- 520. INTRODUCTION TO MIDDLE HIGH GERMAN (3) Descriptive and historical grammar; readings in simple Middle High German texts.
- 521. READINGS IN MIDDLE HIGH GERMAN (3) Intensive reading in Middle High German literature, especially of the *Blütezeit*. Prerequisite: GER 520.
- 522. OLD HIGH GERMAN (3) Essentials of grammar, with special treatment of the High German sound shift; reading of works written before A.D. 1100.
- 523. GOTHIC (3) Introduction to historical and comparative Germanic grammar; emphasis on the Gothic language and texts. Suitable for advanced students in English.
- 525. OLD ICELANDIC (3) Introduction to Old Icelandic grammar; readings in Old Icelandic prose. Suitable for advanced students in English.
- 531. GERMAN LITERATURE OF THE MIDDLE AGES—800 TO 1400 (3) Intensive survey and review of medieval German literature.

*No graduate credit is given for this course.

540. SEMINAR IN GERMAN CULTURE AND CIVILIZATION (3–12) Examination of special problems in German culture and civilization.
541. GERMAN LITERATURE OF THE RENAISSANCE AND BAROQUE (3) Intensive survey and review of German literature between 1450 and 1700.
551. GERMAN LITERATURE FROM THE EARLY ENLIGHTENMENT TO STORM AND STRESS (3) Advanced overview of major developments in German literature from the early to the late 18th century.
552. GERMAN CLASSICISM AND ROMANTICISM (3) Intensive survey of German literature from the late 18th through the first third of the 19th centuries.
561. GERMAN LITERATURE OF THE 19TH CENTURY—FROM BEIDERMEIER TO REALISM (3) Survey of major developments in German literature from the mid- to the late-19th century.
571. GERMAN LITERATURE FROM THE TURN OF THE CENTURY TO 1945 (3) Advanced survey of German literature from the era of Naturalism to that of Exile literature.
572. POST-WAR AND CONTEMPORARY GERMAN LITERATURE (3) Intensive survey of German literature from Gruppe 4 through the literature of the GDR and down to the present.
581. TOPICS IN LITERARY GENRES (3–12) Special studies in the German lyric, drama, short story, and novel.
582. TOPICS IN GERMANIC PHILOLOGY AND GERMAN LINGUISTICS (3 per semester, maximum of 12) Special studies of modern or older Germanic languages.
589. (CMLIT, FR, SPAN) TECHNOLOGY IN FOREIGN LANGUAGE EDUCATION: AN OVERVIEW (3) Approaches to the uses and research applications of multimedia and other educational technologies applied to the teaching of foreign language.
591. GERMAN LITERARY THEORY AND CRITICISM (3–6) Examination of major movements in literary theory and criticism with special reference to German literary thought.
592. SEMINAR IN GERMAN LITERATURE (3 per semester, maximum of 12) Focused investigation of a major figure or theme in German literature.
593. SEMINAR IN GERMAN PHILOLOGY AND GERMAN LINGUISTICS (3 per semester, maximum of 12) Focused investigation of a major topic in Germanic philology or linguistics.
596. INDIVIDUAL STUDIES (1–9)
597. SPECIAL TOPICS (1–9)

HEALTH ADMINISTRATION (H ADM)

School of Public Affairs, Penn State Harrisburg

JAMES T. ZIEGENFUSS, *Coordinator*

W-160 Olmsted Building, 717-948-6053

Graduate Faculty

J. Marvin Bentley, Ph.D. (Tulane) *Associate Professor of Health Economics*

Rupert F. Chisholm, Ph.D. (Case-Western Reserve) *Professor of Management*

Cynthia Zelff Mara, Ph.D. (Virginia Polytechnic) *Assistant Professor of Health Care Administration and Policy*

Christopher K. McKenna, Ph.D. (NYU) *Associate Professor of Management Science*

Robert F. Munzenrider, Ph.D. (Georgia) *Associate Professor of Public Administration*

James T. Ziegenfuss, Ph.D. (Penn/Wharton School) *Professor of Management and Health Care Systems*

Degree Conferred: Master of Health Administration

Recognizing that the national health care system is in a period of reform and redesign, the program emphasis involves design/redesign in a 36-credit curriculum. Based on eight core courses defined as the foundation of administration in health care, the degree is designed for part-time professional students already engaged in health administration careers. The mission of the program is to further student knowledge and skills in a continuous learning cycle. Students are expected not only to know the existing health system, but are to develop a capability for design consistent with demands of access to care, management, and control of costs and quality of care delivery.

Part-time students may start the program at the beginning of any semester. They usually take one or two 3-credit courses each semester. Students may also take one or two courses during the summer session to maintain steady progress toward the degree. All Health Administration courses are available during the evening for the convenience of part-time students. A student may complete the M.H.A. on a part-time basis in about two to four years.

Admission Requirements

Applicants must have received their baccalaureate degree from an accredited college or university prior to starting the graduate program. Applicants who are still completing their baccalaureate requirements at the time of the application may be admitted to the Graduate School conditional on the awarding of the baccalaureate degree.

Admission to the MHA program is based on clear suitability for the MHA program as demonstrated by the application as a whole, to include: a completed application, evidence of a bachelor's degree from an accredited college; a statement of career and educational goals; a successful undergraduate record with a grade-point average of 3.00 (with particular attention given to the last two years of undergraduate work); satisfactory scores on the Graduate Record Examination (GRE) or Graduate Management Admission Test (GMAT) are required if the GPA is less than 3.00; three years of work experience; and names of three references willing to provide recommendations.

The GPA requirement may be relaxed if the student has professional experience or other strong evidence suggesting likely success in the MHA program. Some applicants may be accepted on a non-matriculated probationary basis, pending performance at the B (3.00) level over 15 hours of approved credit.

Program Requirements

All undergraduate degrees are acceptable for admission. All students are expected to have had at least an introductory course in statistics and statistical software.

If these introductory knowledge and skill areas have not been completed prior to admission they must be satisfied prior to completion of 12 graduate credits. Reading and introductory courses—for which not graduate credit is given—are available at Penn State Harrisburg. The computer area may be satisfied by completing a 1-credit computer course: P ADM 486 Applied Statistical Package.

The degree requires a minimum of 36 graduate credits, including a 3-credit, faculty-supervised paper. Three credits of 400-level work may be included in the electives. An overall 3.00 (B) grade-point average must be earned in all 400- and 500-level work.

REQUIRED COURSES: 24 credits

H ADM 539, 540, 541, 542, 545, P ADM 503, 506, 510

ELECTIVE CONCENTRATION: 9 credits

H ADM 546, 548, 597, P ADM 511, 512, 514, 515, 520, 550, 560

CAPSTONE COURSE: 3 credits

H ADM 594

HEALTH ADMINISTRATION (H ADM)

503. (P ADM) RESEARCH METHODS (3) Examination of research methodologies relevant to administration, planning, and public policy. Prerequisite: SCLSC 320. Concurrent: P ADM 486.

506. (P ADM) MANAGEMENT INFORMATION SYSTEMS FOR PUBLIC AND HEALTH ADMINISTRATION (3) The design, implementation, and purpose of computerized management information systems in health and nonprofit organizations. Prerequisite: any course requiring the use of a computer.

510. (P ADM) ORGANIZATION BEHAVIOR (3) Examines the concept of human behavior in formal organizations, systems analysis, conceptual models, and decision processes. Prerequisite: permission of program.

539. HEALTH SYSTEMS ORGANIZATION (3) Health care delivery presented as a socio-technical systems focusing upon resources, policy issues, institutions, technology, and innovations. Prerequisite: permission of program.

540. HEALTH ADMINISTRATIVE POLICY FORMULATION (3) Analysis of administrative problems from a total organization viewpoint. Case studies of actual organizations are used for analysis. Prerequisite: permission of program.

541. HEALTH ECONOMICS AND POLICY (3) Public policy issues, health system components from economic perspective. Economic analysis of health sector, medical markets, health care regulation. Prerequisite: permission of program.

542. HEALTH CARE POLITICS AND POLICY (3) This course reviews political considerations and the policy process as they pertain to health care in the United States. Prerequisite: permission of program.

543. LONG-TERM CARE ADMINISTRATION AND POLICY (3) This course reviews theory and practice related to long-term care administration and policy. Prerequisite: permission of program.

545. HEALTH FINANCIAL MANAGEMENT (3) Theory and techniques of financial management applied to health organizations; forecasting, control systems, working capital, capital budgeting, and institutional financing. Prerequisite: permission of program.

HEALTH EDUCATION

546. **HEALTH PLANNING FOR PUBLIC ADMINISTRATION** (3) Comprehensive planning and program planning for health services, facilities, and manpower; social, economic, and political considerations; methodological problems. Prerequisite: permission of program.

548. **HEALTH CARE QUALITY ASSURANCE** (3) this course reviews theory, methods, outcomes, and management of quality assurance and improvement in health care organizations. Prerequisite: permission of program.

551. **HEALTH CARE LAW** (3) Course on health law for administrators with coverage including hospital governance, taxation, licensure, liability, malpractice, patients' rights, antitrust. Prerequisite: permission of program.

552. **HEALTH DELIVERY SYSTEMS: MANAGED CARE** (3) This course discusses the need for the design of education in managed care in medical schools and health services programs. Prerequisite: permission of program.

594. **RESEARCH TOPICS** (1–15) Supervised student activities on research projects identified on an individual or small-group basis.

596. **INDIVIDUAL STUDIES** (1–9)

HEALTH EDUCATION (HLHED)

SAMUEL W. MONISMITH, *Program Coordinator*
Penn State Harrisburg
717-948-6515

Degrees Conferred: M.Ed.

The Graduate Faculty

Barbara Bremer, Ph.D. (Bryn Mawr) *Associate Professor of Psychology*

Robert J. Lesniak, Ph.D. (Syracuse) *Associate Professor of Education*

Beverly S. Mahoney, Ph.D. (Penn State) *Assistant Professor of Health Education*

Samuel W. Monismith, D.Ed. (Penn State) *Associate Professor of Health Education*

James F. Rooney, Ph.D. (Pennsylvania) *Professor of Sociology*

Rita Shell, Ph.D. (Arizona) *Assistant Professor of Psychology*

Health education is a profession that complements other health-related fields such as medicine, nursing, health care administration, and preventive psychology. The program follows a professional development paradigm, as many of the students are employed in the broad area of health and are pursuing graduate study on a part-time basis. The M.Ed. is a professional degree emphasizing applied research. The program requires a research-based culminating experience. The faculty has a broad range of interests, including health promotion, family systems, teaching and training methods, violence and substance abuse prevention and control, and multicultural health issues.

Admission Requirements

Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION and APPLICATION AND ADMISSION sections of the *Graduate Bulletin*.

An overall minimum undergraduate grade-point average of 2.50 and a junior/senior grade-point average of 3.00 (on a 4.00 scale) is required for admission into the program. The applicant is further evaluated on the basis of related prior course work, work experience in the field, expression of career interests and recommendations. Exceptions to the stated admission requirements may be made for students with special backgrounds, abilities, and interests.

Degree Requirements

A minimum of 30 graduate credits is required for the completion of the degree. A 3-credit research-based culminating experience is required. The program has a required core of courses totalling 18 credits as follows:

HLHED 415 PLANNING AND DEVELOPMENT OF HEALTH EDUCATION PROGRAMS (3)

HLHED 456 ADVANCED TECHNIQUES IN SCHOOL AND COMMUNITY HEALTH EDUCATION (3)

EDUC 440 EDUCATION STATISTICS AND MEASUREMENT (3)

HLHED 552 CURRENT HEALTH EDUCATION ISSUES (3)
 EDUC 586 EDUCATIONAL RESEARCH DESIGN (3)
 or HLHED 530 RESEARCH TECHNIQUES IN HEALTH EDUCATION (3)
 and

Culminating Experience:

HLHED 591 CULMINATING HEALTH EDUCATION SEMINAR (3)
 or HLHED 587 MASTER'S PROJECT (3)

Note: Students can earn credit for *either* HL ED or HLHED courses *carrying the same number*.

Electives

A minimum of 12 credits is to be selected from the following HLHED courses or from suitable courses in Applied Psychology, Community Psychology, Training and Development, or Public Administration programs. Note that 6 credits must be at the 500 level: HLHED 420, 421, 443, 450, 501, 516, 590, 596.

Please contact the program office for further information on electives.

HEALTH POLICY AND ADMINISTRATION (H P A)

S. DIANE BRANNON, *Head*
 104 Henderson Building
 814-863-5421

Degree Conferred: Ph.D., M.S., M.B.A./M.H.A. (concurrent)

The Graduate Faculty

S. Diane Brannon, Ph.D. (Cornell) *Professor of Health Policy and Administration*
 Kathryn H. Dansky, Ph.D. (Ohio State) *Associate Professor of Health Policy and Administration*
 Frederick R. Eisele, Ph.D. (NYU) *Associate Professor of Health Policy and Administration*
 Stephen E. Foreman, J.D., Ph.D. (California, Berkeley) *Assistant Professor of Health Policy and Administration*
 Larry D. Gamm, Ph.D. (Iowa) *Associate Professor of Health Policy and Administration*
 Joe A. Miller, Ph.D. (Michigan State) *Associate Professor of Health Policy and Administration*
 Dennis Scanlon, Ph.D. (University of Michigan) *Assistant Professor of Health Policy and Administration*
 Dennis G. Shea, Ph.D. (Rutgers) *Assistant Professor of Health Policy and Administration and Economics*
 Pamela Farley-Short, Ph.D. (Yale) *Professor of Health Policy Administration and Director, Center for Health Policy Research*
 Robert Weech-Maldonado, M.B.A. (Temple University) *Instructor, Health Policy and Administration*
 Charles E. Yesalis III, Sc.D. (Johns Hopkins) *Professor of Health Policy and Administration*
 Lucy C. Yu, Ph.D. (Michigan) *Associate Professor of Health Policy and Administration*

Graduate degrees in this program are offered by the faculty of the Department of Health Policy and Administration, in the College of Health and Human Development. The program's focus is on management, policy, and research health care systems, with particular attention to recurrent problems of cost, quality, and access to health services.

The professional Master of Health Administration (M.H.A.) program is offered concurrently with the Master of Business Administration (M.B.A.) program. The M.H.A. program helps prepare students for managerial positions in hospitals, nursing homes, managed care organizations, and mental health services, as well as health insurance and pharmaceutical companies, etc. The M.H.A. curriculum covers the nature of health and illness, the structure of health service systems, health policy, and specific issues related to the management of health care organizations.

The doctoral and M.S. programs provide advanced training in health services research, policy, and administration, leading to positions in universities, governmental agencies, and other research and educational settings. In addition to active research mentoring by H P A full-time faculty, Ph.D. students also may work with faculty from diverse units across the University, such as economics, statistics, management, rural sociology, and finance.

H P A faculty members have research projects in long-term care, rural health services, medical care organization, consumer choice in health care markets, information systems, and national and state health care policies. Additional opportunities for research and other scholarly activities are available through the University's Center for Health Policy Research and Gerontology Center which has strong ties to the H P A department.

M.B.A./M.H.A. Admission and Degree Requirements

Admission to the M.H.A. program is open only to students who are admitted concurrently to the M.B.A. program at University Park campus or who have earned an M.B.A. from an accredited business college within five years of acceptance into the M.H.A. program. Scores from the Graduate Management Admission Test (GMAT) are required for admission. Work on the M.H. A. degree may be started fall semester only.

The M.H.A. degree is designed to be completed in 21-months of full-time study and must be taken concurrently with the M.B.A. degree offered by the Smeal College of Business Administration. A portion of the graduate credits are counted for both the M.H.A. and M.B.A. programs, thus making it possible to complete the program in the suggested time period. Much of the core management content is taken within the M.B.A. program in conjunction with that program's required courses. The 37 credits of required and elective courses in the M.H.A. program focus on content in health care organization, policy, finance, administration, information systems, law, and epidemiology. Included within these required credits are a 4-week summer intercession course, a 10-week integrative internship during the summer following the first year of study, and an integrative capstone seminar experience occurring during the fourth academic semester.

M.S. Admission and Degree Requirements

Scores from the Graduate Record Examination (GRE) or the Graduate Management Admission Test (GMAT) are required for admission into the M.S. program. Requirements listed here are in addition to general Graduate School requirements stated in the General Information section of the *Graduate Bulletin*.

A junior/senior grade-point average of 3.00 or better (on a 4.00 scale); competitive GRE or GMAT scores; and a well-considered statement of experience and career goals are major criteria for admission. Some work experience in health services is desirable. Deficiencies in one area may be offset by significant strength in the remaining areas.

The Master of Science degree in Health Policy and Administration is designed to prepare individuals for further academic research or for research/analytic work in nonacademic settings related to a diverse range of health services topics. The objectives of the M.S. in Health Policy and Administration (H P A) are to produce professionals to participate in health services research and conduct data analyses supporting planning, policy development, evaluation, and/or administration in a variety of settings concerned with health policy and administration.

Accordingly, the goal of the M.S. course sequence is to provide didactic emphasis to work in statistics and data management, health services research methods and mentored research. M.S. students will also receive an introduction to the theoretic underpinnings of health services research (health economics, health care organization theory and epidemiology). Program graduates will be able to serve as health services research support staff and will have the requisite skills to enable them to commence and make rapid progress toward a Ph.D.

A minimum of 40 credits is required for completion of the degree. At least 15 credits of the program must be completed in H P A departmental course offerings at the 400 and 500 level. At least 18 credits of the degree must be in 500- and 600-level courses. A 6-credit master's thesis must be completed as part of the degree requirement.

Doctoral Admission and Degree Requirements

Scores from the Graduate Record Examination (GRE) or the Graduate Management Admission Test (GMAT) are required for admission into the doctoral program. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

A junior/senior grade-point average of 3.00 or better (on a 4.00 scale); competitive GRE or GMAT scores; and a well-considered statement of experience and career goals are major criteria for admission. Some work experience in health services is desirable. Deficiencies in one area may be offset by significant strength in the remaining areas.

The Ph.D. program is designed to provide advanced training in health policy, health administration, and health services research to qualified candidates with varied backgrounds. For persons with a master's degree in health administration or related area—an M.H.A. or M.P.A., for example—the course of study typically entails two years of course work and one-two years of dissertation research.

The H P A doctoral curriculum is built around four substantive areas: (1) 6 credits of core courses in health, including doctoral seminars, (2) 3 to 6 credits in microeconomics and 6 credits in organizational theory, (3) 18 credits in research methods and statistics, and (4) 15 credits in specialty emphasis or minor field courses. In addition to completing all formal course work with a grade-point average of 3.00 or better,

doctoral students must pass a candidacy review, show competency in English and use of statistical computer packages, pass a series of comprehensive examinations, and successfully defend their thesis in a final oral examination.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

HEALTH POLICY AND ADMINISTRATION (H P A)

- 401. COMPARATIVE HEALTH SYSTEMS (3)
- 410. PRINCIPLES OF PUBLIC HEALTH ADMINISTRATION (3)
- 420. PRINCIPLES OF MANAGED CARE (3–6)
- 431. HEALTH PLANNING METHODS (3)
- 433. ADMINISTRATION OF HOSPITAL AND HEALTH SERVICES SYSTEMS (3)
- 440. PRINCIPLES OF EPIDEMIOLOGY (3)
- 442. LONG-TERM CARE MANAGEMENT (3)
- 445. (ECON) HEALTH ECONOMICS (3)
- 447. FINANCING HEALTH CARE (3)
- 450. HEALTH CARE POLICIES AND POLITICS (3)
- 455. STRATEGIC PLANNING AND MARKETING FOR HEALTH SERVICES (3)
- 460. HUMAN RESOURCE MANAGEMENT IN HEALTH CARE ORGANIZATIONS (3)
- 496. INDEPENDENT STUDIES (1–18)
- 497. SPECIAL TOPICS (1–9)

- 503. UNDERSTANDING ORGANIZATIONAL BEHAVIOR (3) A systematic application of the principles of organizational behavior to understanding professional roles in human services organizations.
- 504. INTERORGANIZATIONAL RELATIONS (3) Interorganizational concepts and their application to analysis of policies, programs, and service delivery concerns involving health and human services organizations.
- 505. PROCESSES OF PLANNED CHANGE (3) Exploration of diagnostic and intervention strategies employed in planned change in health and human services organizations and programs.
- 521. INTRODUCTION TO HEALTH SERVICES (2) An introduction to the organization and utilization of health services in the United States.
- 522. HEALTH POLITICS, POLICY, AND FINANCE (2) An introduction to health politics, health policy, and health services payment systems in the United States. Prerequisite: H P A 521.
- 524. MANAGEMENT OF HEALTH SERVICES ORGANIZATIONS (3) A systematic study of the roles of health services managers and the organizational and environmental context within which they work.
- 525. HOSPITAL AND HEALTH SERVICES ADMINISTRATION (3) A study of decision making in hospitals and health organizations; the process of decision making, incorporating various techniques and strategies. Prerequisites: H P A 522.
- 527. APPROACHES TO HEALTH PLANNING (3) A systematic exploration of approaches to health planning and an application of health planning techniques.
- 528. HEALTH DATA ANALYSIS (3) Foundations of secondary data analysis on health conditions, services, organizations, and finances. Prerequisites: STAT 200 or 451.
- 530. HEALTH CARE HUMAN RESOURCES MANAGEMENT (3) The scope and significance of human resource management roles, issues, and skills in health care delivery systems. Prerequisites: H P A 522.
- 531. HEALTH PROBLEM ANALYSIS (3) Logic of empirical inquiry in study of community problems in health; integration of theory and practice, technical data and values.
- 535. FINANCIAL MANAGEMENT IN HEALTH INSTITUTIONS (3) The financial environment of health institutions; financial aspects of management decision making; emphasis on reimbursement, capital investment, and financing. Prerequisites: H P A 522, B A 511 and 531.
- 536. HEALTH LAW (3) The legal process as it applies to the health administrator, health organization, medical provider, and patient. Prerequisite: H P A 522.
- 547. HEALTH SERVICES REIMBURSEMENT (3) Analysis of third-party reimbursement of health care providers.
- 555. INFORMATION SYSTEMS IN HEALTH SERVICES ADMINISTRATION (3) Foundations of information systems for supporting clinical services, quality improvement, and administrative functions in health services management. Prerequisites: H P A 522, H P A 525.

HIGHER EDUCATION

556. STRATEGY DEVELOPMENT IN HEALTH SERVICES ORGANIZATION (3) Integration of prior course work in the program to develop a strategic plan for a health services organization. Prerequisites: H P A 440, 535, 555.

561. INTRODUCTION TO RESEARCH DESIGN IN HEALTH SERVICES RESEARCH (3) General form and philosophy of inquiry in social sciences as applied to research issues in health policy and administration.

562. RESEARCH IN HEALTH SERVICE UTILIZATION (3) Critical examination of empirical work as it applies to the utilization component of a conceptual model of the medical care system. Prerequisites: H P A 561.

563. RESEARCH IN HEALTH SERVICE DELIVERY (3) Research in structure and central management functions of health services delivery organizations, and development and implementation of health policy. Prerequisite: H P A 524, 561.

564. RESEARCH METHODS IN HEALTH SERVICES RESEARCH (3) Development and critical analysis of a research proposal. Prerequisite: H P A 561, 562, 563.

590. COLLOQUIUM (1-3)

595. INTERNSHIP (1-18)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

M.H.A ADDITIONAL SPECIFIC REQUIREMENTS

The professional Master of Health Administration (M.H.A.) Program is offered concurrently with the Master of Business Administration (M.B.A.) program. The M.H.A program prepares the students for managerial positions in hospitals, nursing homes, managed care organizations, as well as health insurance and pharmaceutical companies, etc. The M.H.A curriculum includes health administration, the nature of health and illness, the structure of health service systems and health policy.

Scores from the Graduate Management Admission Test (GMAT) are required for admission into the M.H.A./M.B.A concurrent degree program. The M.H.A. degree requirements include three pre-program requirements and a minimum of 37 credits of graduate courses taken concurrently with M.B.A. credits for a total of 63 credits for the M.H.A. and M.B.A concurrent degrees.

Before entering, students must have demonstrated proficiency equivalent to the material in an undergraduate course in microeconomics, introductory financial accounting, and introductory statistics. These courses will not be counted toward the M.H.A. degree. The program office can provide information on different vehicles for meeting these preprogram requirements.

M.H.A. degree is designed to be completed in twenty-one months of full-time study and must be taken concurrently with the M.B.A. degree offered by The Smeal College of Business Administration. A portion on the graduate credits are counted for both the M.H.A. and M.B.A. programs, thus making it possible to complete the program in the suggested time period. Much of the core management content is taken with the M.B.A. program in conjunction with that program's required courses. The 37 credits of required and elective courses in the M.H.A. program focus on content in health care organization, policy, finance, administration, information systems, law, and epidemiology. Included also, within these required credits are a four-week summer intersession course, and a 10-week integrative internship during the summer following the first year of study, and an integrative capstone seminar experience occurring during the fourth academic semester.

HIGHER EDUCATION (HI ED)

ROGER L. GEIGER, *In Charge of Graduate Programs in Higher Education*
115 Charlotte Building
814-863-2690

Degrees Conferred: Ph.D., D.Ed., M.Ed.

The Graduate Faculty

Alberto F. Cabrera, Ph.D. (Wisconsin—Madison) *Associate Professor of Education*

Carol L. Colbeck, Ph.D. (Stanford) *Assistant Professor of Education*

Michael Dooris, Ph.D. (Penn State) *Affiliate Assistant Professor of Education*

Roger L. Geiger, Ph.D. (Michigan) *Professor of Education*

Elizabeth M. Hawthorne, Ph.D. (Michigan) *Associate Professor of Education*

Robert M. Hendrickson, Ed.D. (Indiana) *Professor of Education*

David M. Post, Ph.D. (Chicago) *Associate Professor of Education*

James L. Ratcliff, Ph.D. (Washington State) *Professor of Education*

Patrick T. Terenzini, Ph.D. (Syracuse) *Professor of Education*

M. Lee Upcraft, Ph.D. (Michigan State) *Affiliate Professor Emeritus of Education*

Maryellen G. Weimer, Ph.D. (Penn State) *Affiliate Assistant Professor of Education*

The graduate program in Higher Education has as its goal the preparation of individuals who will pursue careers and exert leadership in postsecondary education as administrators, faculty, or researchers in the nation's colleges and universities and in a variety of public and private agencies and associations in the United States and other nations. With emphasis on the systematic study of higher education, the program builds on the scholarly and scientific disciplines offered throughout the University and applies these studies to the professional functions and responsibilities that its graduates will assume, and to the knowledge of the field of higher education. The program is concerned with four broad areas of higher education study and with three areas of special emphasis: academic programs and evaluation, organization and administration, and perspectives on higher education policy and practice.

With mounting awareness of the changes occurring in various academic and professional fields, of the need for higher education reform, and of the need for improved articulation among the various levels of education, higher education faculty cooperates with other departments of the University to offer a number of courses and seminars for graduate students interested in pursuing a minor in higher education.

Admission Requirements

Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by the graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

The best-qualified applicants will be accepted up to the number of spaces that are available for new students. The Miller Analogies Test (MAT) has been accepted by the program and authorized by the dean of the Graduate School for use in admission decisions as a substitute for the GRE. Applicants with a standardized test score above 60 on the MAT, or a total Verbal and Quantitative score above 1100 on the GRE, and with a junior/senior average of 3.00 and a graduate average of 3.50 (on a 4.00 scale) are usually admitted to the Ph.D. and D.Ed. programs. Applicants with a junior/senior average of 2.70, a graduate average of 3.20, and an MAT score of 50 or a GRE total score of 1000 but with special backgrounds, abilities, and interests also may be admitted to the Ph.D. program with only the baccalaureate degree, but they will earn the master's degree enroute.

APPLICATION DEADLINE: Candidates may enter the program at the beginning of the fall or spring semester, or the summer session. To allow sufficient time for processing applications, required information must be received by February 1 for summer session and fall semester, or by September 15 for the spring semester. Applicants should contact the program office for additional application materials.

HIGHER EDUCATION (HI ED)

497, 498. SPECIAL TOPICS (1–9)

502. (CI ED, EDTHP 506) EDUCATIONAL MOBILITY IN COMPARATIVE PERSPECTIVE (3) Role of education in social mobility, using quantitative, qualitative, and historical methods; focuses comparatively on Britain, East Asia, and South America.

503. (CI ED, EDTHP 507) ETHNICITY, NATIONAL IDENTITY, AND EDUCATION (3) Surveys group-oriented education policies internationally, especially comparing those of Britain, Taiwan, India.

545. HIGHER EDUCATION IN THE UNITED STATES (3) Introduction to the educational context and major organizational and academic characteristics of postsecondary education; analysis of issues and future trends.

546. COLLEGE TEACHING (2–3) Principles involved in teaching at the college level; effective use of teaching aids; criteria used in evaluation.

548. CURRICULUMS IN HIGHER EDUCATION (2–3) Various types of curriculums and philosophies underlying them; ways in which curriculums are developed; elective versus required courses; evaluation of achievement.

549. (ADTED) COMMUNITY JUNIOR COLLEGE AND THE TECHNICAL INSTITUTE (2-3) Distinctive contributions to meeting the need for postsecondary education; development, functions, curriculum and instruction, government, administration, and finance.

552. ADMINISTRATION IN HIGHER EDUCATION (3) Philosophy of administration; principles of scientific management and their application in colleges and universities; case studies of administrative problems. Prerequisite: courses or experience in higher education.

HISTORY

554. THE HISTORY OF AMERICAN HIGHER EDUCATION (3) An examination of the development of American higher education against the background of influential social, political, economic and intellectual issues.
556. HIGHER EDUCATION STUDENTS AND CLIENTELE (3) Characteristics of higher postsecondary education students and other clientele; changes during postsecondary education years and during college; educational challenges and responses.
560. LEGAL ISSUES IN HIGHER EDUCATION (3) A process for analyzing case law on issues of access, student rights, employment, collective bargaining, church/state, private sector, and liability.
562. ORGANIZATIONAL THEORY AND HIGHER EDUCATION (3) Application of social science theory and research to postsecondary education organizations and administration; use of research in administrative practice. Prerequisite: HI ED 552.
565. RESEARCH DESIGN: IMPLICATIONS FOR DECISIONS AND POLICY IN HIGHER EDUCATION (3) A capstone course on research design and analytical approaches in decision making in higher education from several policy perspectives for dissertation proposal preparation. Prerequisites: EDPSY 400, 406; or AG 400, R SOC 522.
566. QUALITATIVE METHODS IN EDUCATIONAL RESEARCH (3) Exploration of the theoretical framework undergirding qualitative research and its attendant practices and techniques. Prerequisite: completion of core courses in higher education.
571. (CI ED) COMPARATIVE HIGHER EDUCATION (3) Comparative methods of studying structural variations in systems of higher education in principal industrialized nations and other selected countries.
590. COLLOQUIUM (1-3)
594. RESEARCH TOPICS (1-9) Application of research methods to problems of organization, management, and policy in higher education; preparation of research proposal for the completion of the dissertation.
595. INTERNSHIP IN HIGHER EDUCATION (1-9) Supervised experience in administrative offices, in research, on instructional teams, and in college teaching.
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

HISTORY (HIST)

A. GREGG ROEBER, *Head of the Department*
DAN P. SILVERMAN, *Director of Graduate Studies*
108 Weaver Building
814-865-1367

Degrees Conferred: Ph.D., M.A.

The Graduate Faculty

Charles D. Ameringer, Ph.D. (Fletcher Sch. Law & Dipl.) *Professor Emeritus of Latin American History*
Daniel C. Beaver, Ph.D. (Chicago) *Associate Professor of History*
Eugene N. Borza, Ph.D. (Chicago) *Professor Emeritus of Ancient History*
Kumkum Chatterjee, Ph.D. (Calcutta, India) *Associate Professor of History*
Priscilla F. Clement, Ph.D. (Pennsylvania) *Associate Professor of History*
Gary S. Cross, Ph.D. (Wisconsin, Madison) *Professor of European History*
William J. Duiker III, Ph.D. (Georgetown) *Professor Emeritus of History and Liberal Arts and Professor of East Asian Studies*
Gerald G. Eggert, Ph.D. (Michigan) *Professor Emeritus of American History*
George M. Enteen, Ph.D. (George Washington) *Professor Emeritus of Russian History*
John B. Frantz, Ph.D. (Pennsylvania) *Associate Professor Emeritus of American History*
Lori D. Ginzberg, Ph.D. (Yale) *Associate Professor of History and Women's Studies*
Thavolia Glymph, Ph.D. (Purdue) *Assistant Professor of History*
Arthur E. Goldschmidt, Jr., Ph.D. (Harvard) *Professor of Middle East History*
Amy Greenberg, Ph.D. (Harvard) *Assistant Professor of History*
Baruch Halpern, Ph.D. (Harvard) *Professor of Ancient History and Mediterranean Studies, and Religious Studies; Chair, Jewish Studies*
Paul B. Harvey, Jr., Ph.D. (Pennsylvania) *Associate Professor of History and Classics*
Claire Hirshfield, Ph.D. (Pennsylvania) *Professor Emerita of European History*

- Benjamin T. Hudson, Ph.D. (Oxford) *Associate Professor of History and Medieval Studies*
 Natalie K. Isser, Ph.D. (Pennsylvania) *Professor Emerita of European History*
 Philip Jenkins, Ph.D. (Cambridge) *Distinguished Professor of Religious Studies and History*
 Isabel F. Knight, Ph.D. (Yale) *Associate Professor Emerita of History*
 Joan B. Landes, Ph.D. (NYU) *Professor of Women's Studies and History*
 Daniel L. Letwin, Ph.D. (Yale) *Associate Professor of American History*
 Kathleen L. Lodwick, Ph.D. (Arizona) *Professor of Modern Chinese History*
 Robert J. Maddox, Ph.D. (Rutgers) *Professor Emeritus of American History*
 David McBride, Ph.D. (Columbia) *Professor of African/African American Studies and African American History*
 Sally A. McMurry, Ph.D. (Cornell) *Professor of American History*
 Carl I. Meyerhuber, Ph.D. (California, San Diego) *Associate Professor of History*
 Wilson J. Moses, Ph.D. (Brown) *Professor of American History*
 Mark Munn, Ph.D. (Bryn Mawr) *Associate Professor of History*
 On-Cho Ng, Ph.D. (Hawaii, Manoa) *Professor of History*
 William A. Pencak, Ph.D. (Columbia) *Professor of American History*
 Robert N. Proctor, Ph.D. (Harvard) *Professor of the History of Science*
 Carol Reardon, Ph.D. (Kentucky) *Associate Professor of History*
 P. Peter Rebanc, Ph.D. (Michigan State) *Associate Professor of History*
 A.G. Roeber, Ph.D. (Brown) *Professor of Early Modern History and Religious Studies*
 Adam Rome, Ph.D. (Kansas) *Assistant Professor of History and Geography*
 Anne Carver Rose, Ph.D. (Yale) *Associate Professor of History and Religious Studies*
 Paul Lawrence Rose, Ph.D. (Sorbonne) *Professor of European History and Mitrani Professor of Jewish Studies*
 Guido Ruggiero, Ph.D. (UCLA) *Josephine Berry Weiss Chair in the Humanities and Professor of Renaissance History*
 Janina Safran, Ph.D. (Harvard) *Assistant Professor of History*
 Londa L. Schiebinger, Ph.D. (Harvard) *Professor of the History of Science and Women's Studies*
 Dan P. Silverman, Ph.D. (Yale) *Professor of European History*
 Gregory Smits, Ph.D. (Southern California) *Assistant Professor of History*
 Jackson J. Spielvogel, Ph.D. (Ohio State) *Associate Professor of History*
 James Ross Sweeney, Ph.D. (Cornell) *Professor of Medieval History*
 Christine A. White, Ph.D. (Cambridge) *Associate Professor of History*
 Michael Wolfe, Ph.D. (Johns Hopkins) *Associate Professor of History*
 Nan E. Woodruff, Ph.D. (Tennessee) *Associate Professor of History*

Graduate instruction at the master's degree level is offered in the following areas of history: the Ancient Mediterranean; Medieval, Early Modern, and Modern European, including Great Britain and Russia; the United States, including colonial American and African American History; the Middle East; East and South Asian; and Latin America. In addition, graduate instruction is offered in such comparative or topical areas as Military History, Women's History, History of Religion, Jewish History, and the History of Science.

Doctoral programs ordinarily are limited to American, Ancient, Medieval, Early Modern British and European, Modern European, and East Asian History; as well as comparative studies in the History of War and Society; Women's History; the History of Industry, Agriculture, and Society; the History of Science and Technology; and the History of Religion. Prospective doctoral candidates are invited to contact the graduate officer about the current availability of any of these or other areas before applying.

Admission Requirements

Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Applicants to the doctoral program must hold or be near completion of the master's degree (or its equivalent); all others will be considered for admission to the master's program, even if it is their ultimate intention to pursue a doctoral degree at Penn State.

To be considered for admission, applicants must submit transcripts that show (1) substantial course work in history with a minimum grade-point average of 3.50 (on a 4.00 scale) in all undergraduate history courses, (2) a minimum junior/senior GPA in all courses of 3.30, (3) at least three semesters of college-level work in a foreign language (additional language training appropriate to the fields in which the applicant proposes to work may also be required for admission) and, (4) where applicable, a minimum GPA of 3.50 for all graduate work previously undertaken. Each applicant must submit the scores of the Graduate

Record Examination (GRE) taken within five years previous to the date of application; the general examination scores are mandatory, the history examination is optional. Students with scores of 650 or better in each of the verbal, quantitative, and analytic sections of the general examination will be given preference in admission. Applicants from abroad whose native language is not English must submit the scores of TOEFL to the Graduate School; admission to the history program normally requires a score of 600 or better.

The Department of History further requires all applicants to submit directly to the department a statement of intent outlining their proposed fields of study and career goals, as well as a sample of their written work (undergraduate history thesis, master's thesis, seminar paper or equivalent research paper) as evidence of their historical research and writing skills. Three letters of recommendation are required; it is strongly preferred that at least two of them be from historians.

Master's Degree Requirements

(1) Candidates for the M.A. degree must earn a minimum of 33 credits of graduate-level work, of which 18 credits will be in the student's major area and 6 credits each in two other areas, one of which may be in another discipline. History 501 (Historical Method) or a graduate-level course in research methods specific to the student's major area is required of all master's degree candidates. (2) Reading proficiency in at least one foreign language must be demonstrated no later than the beginning of the second year of residence. (3) Students electing to write a master's thesis will take 6 credits of thesis research as part of the 18 credits in their major area, and will be given an oral examination on the thesis and topics related to the thesis. Students electing to write a paper in lieu of the thesis will be given an oral examination based on course and seminar work in history.

Doctoral Degree Requirements

History 501 (Historical Method) and 502 (Historiography) or their equivalents are required of all doctoral students. The remainder of a student's doctoral program, including foreign language requirements, will be determined by the doctoral committee. In order to be admitted to doctoral candidacy, students must submit a historiographical essay in the proposed research field and pass an oral examination (the candidacy examination) on the essay and on possible dissertation topics suggested by the essay. After completing all course work, doctoral candidates must pass written and oral examinations in the research field, a primary area of specialization, and two additional areas (one of which may be outside the discipline of history). Upon completion of the doctoral dissertation, the candidate must pass a final oral examination (the dissertation defense) to earn the degree.

Other Relevant Information

The department's graduate officer, who supervises the overall graduate program in history and maintains student records, will assign newly admitted graduate students to advisers on the basis of each student's expressed area of interest. Advisers provide assistance in planning courses of study, guidance in choosing thesis and dissertation topics, direction in conducting research, and career counseling. Students who serve as graduate assistants will be given a variety of experiences as they assist different professors, ranging from paper-grading and administering exams, to preparing and delivering occasional lectures, to conducting review or discussion sections for large lecture courses. Advanced doctoral students may hold lectureships while working on their dissertations; lecturers have complete instructional responsibility for one or two sections of an undergraduate course in their area of specialization.

Student Aid

In addition to the fellowships, graduate assistantships, and other forms of financial aid described in the STUDENT AID section of the *Graduate Bulletin*, the following awards typically have been available to graduate students in this program:

JAMES HAMILTON HARTZELL AND LUCRETIA IRVINE BOYD HARTZELL HISTORY AWARD—A \$200 to \$300 award made annually to a graduate student in the Department of History whose field of interest is Pennsylvania history.

JAMES LANDING FELLOWSHIP FOR STUDY IN CIVIL WAR—One fellowship is available each year to doctoral candidates who are working on their dissertations. The award consists of a stipend of approximately \$15,000, with no tuition waiver.

HILL FELLOWSHIPS FOR STUDY IN HISTORY—Awarded annually by the Department of History to doctoral candidates who are working on their dissertations. The amount of the award varies, but it generally supports one semester free of duties.

EDWIN ERLE SPARKS FELLOWSHIP IN THE HUMANITIES—One fellowship is available each year to doctoral candidates in the Department of History who are working on their dissertations; the award for 1998–99 consists of a stipend of \$12,645 plus waiver of tuition.

MARK AND LUCY MACMILLAN STITZER AWARD—Awarded by the Department of History each year to support graduate student travel for the purpose of research. The number and value of these awards depends on the quality of proposals received, the level of funding required by each meritorious project, and the funds available in the endowment. Preference is given to requests for doctoral dissertation research.

THE E-TU ZEN SUN AWARD FOR OUTSTANDING TEACHING BY A GRADUATE ASSISTANT—One award is made each year to recognize excellence in teaching by a History graduate assistant in the conduct of discussion sections, review sessions, or lecture presentations. The value of the award varies depending on funds available, but it is normally about \$500.

HISTORY (HIST)

- 402. THE RISE OF THE GREEK POLIS (3)
- 403. ALEXANDER THE GREAT AND THE HELLENISTIC WORLD (3)
- 404W. ROME AND HELLENISM (3)
- 405W. THE ROMAN EMPIRE (3)
- 407. EARLY MEDIEVAL SOCIETY (3)
- 408. CHURCH AND STATE IN THE HIGH MIDDLE AGES (3)
- 411. (MEDVL) MEDIEVAL BRITAIN (3)
- 412. INTELLECTUAL HISTORY OF THE MIDDLE AGES (3)
- 413. (MEDVL) MEDIEVAL CELTIC STUDIES (3)
- 414. RENAISSANCE AND REFORMATION (3)
- 416. (J ST) ZIONIST HISTORY 1898–1948 (3)
- 417. THE AGE OF ABSOLUTISM (3)
- 418. THE FRENCH REVOLUTION AND THE NAPOLEONIC ERA (3)
- 419. (WMNST) THE HISTORY OF FEMINIST THOUGHT (3)
- 420. RECENT EUROPEAN HISTORY (3)
- 421. (WMNST) HISTORY OF EUROPEAN WOMEN (3)
- 422. MODERNITY AND ITS CRITICS: EUROPEAN THOUGHT SINCE 1870 (3)
- 423. ECONOMIC HISTORY OF EUROPE SINCE 1750 (3)
- 425. WORK AND LEISURE IN INDUSTRIAL EUROPE (3)
- 427. GERMANY SINCE 1860 (3)
- 428. (S T S) THE DARWINIAN REVOLUTION (3)
- 430. EASTERN EUROPE IN MODERN TIMES (3)
- 433. IMPERIAL RUSSIA, 1700–1917 (3)
- 434. HISTORY OF THE SOVIET UNION (3)
- 436. GREAT BRITAIN UNDER THE TUDORS AND STUARTS, 1485–1688 (3)
- 437. GREAT BRITAIN, 1688–1867 (3)
- 438. GREAT BRITAIN, 1867–PRESENT (3)
- 440. COLONIAL AMERICA TO 1753 (3)
- 441. REVOLUTIONARY AMERICA, 1753–1783 (3)
- 442. THE EARLY AMERICAN REPUBLIC, 1783–1850 (3)
- 444. THE UNITED STATES IN CIVIL WAR AND RECONSTRUCTION—1850–1877 (3)
- 445. THE EMERGENCE OF MODERN AMERICA (3)
- 446. AMERICA BETWEEN THE WARS (3)
- 447. RECENT AMERICAN HISTORY (3)
- 448. AMERICA IN THE 1960s (3)
- 449. CONSTITUTIONAL HISTORY OF THE UNITED STATES TO 1877 (3)
- 450. CONSTITUTIONAL HISTORY OF THE UNITED STATES SINCE 1877 (3)
- 452. HISTORY OF U.S. FOREIGN RELATIONS (3)
- 453. (GEOG 407) AMERICAN ENVIRONMENTAL HISTORY (3)
- 454. AMERICAN MILITARY HISTORY (3)
- 455. LESBIAN AND GAY HISTORY (3)
- 456W. THE SOCIAL HISTORY OF AMERICAN VERNACULAR BUILDING, 1607–1980 (3)
- 457. (WMNST, S T S) HISTORY OF WOMEN IN SCIENCE (3)
- 458W. (L I R) HISTORY OF AMERICAN ORGANIZED LABOR SINCE 1877 (3)
- 459W. SOCIAL AND CULTURAL HISTORY OF THE UNITED STATES SINCE 1783 (3)
- 460. UNITED STATES FOREIGN INTELLIGENCE (3)
- 467. LATIN AMERICA AND THE UNITED STATES (3)
- 468. MEXICO AND THE CARIBBEAN NATIONS IN THE TWENTIETH CENTURY (3)
- 471W. HISTORY OF ARABIC CIVILIZATION, 600–1258 (3)
- 472. THE OTTOMAN EMPIRE AND OTHER MUSLIM STATES (3)

473. THE CONTEMPORARY MIDDLE EAST (3)
 - 475W. THE MAKING AND EMERGENCE OF MODERN INDIA (3)
 479. HISTORY OF IMPERIALISM AND NATIONALISM IN AFRICA (3)
 480. MEDIEVAL JAPAN (3)
 481. MODERN JAPAN SINCE 1800 (3)
 483. CHINESE SOCIETY AND CULTURE TO 1800 (3)
 - 484W. HISTORY OF CHINESE THOUGHT (3)
 - 485W. NINETEENTH-CENTURY CHINA (3)
 486. TWENTIETH-CENTURY CHINA (3)
 488. TWENTIETH-CENTURY SOUTHEAST ASIA (3)
 490. (L ST) ARCHIVAL MANAGEMENT (1-3)
 493. PRECEPTORSHIP IN TEACHING (3-6)
 494. RESEARCH PROJECT (1-12)
 495. INTERNSHIP (1-18)
 496. INDEPENDENT STUDIES (1-18)
 497. SPECIAL TOPICS (1-9)
 499. FOREIGN STUDY—HISTORY (1-6)
-
501. HISTORICAL METHOD (3)
 502. HISTORIOGRAPHY (3)
 503. STUDIES IN GREEK HISTORY (3-6)
 504. STUDIES IN ROMAN HISTORY (3-6)
 505. (J ST) BIBLICAL HISTORIOGRAPHY IN ITS ANCIENT SETTING (3 per semester, maximum of 6) Methods of historical reconstruction in Biblical and other historiography from the earliest Mesopotamian records through those of the sixth century B.C.E. Prerequisite: HIST 102.
 508. (J ST) ANTISEMITISM IN HISTORICAL CONTEXT (3) Historical and comparative analysis of occurrences of antisemitism from antiquity to the present.
 509. MEDIEVAL CIVILIZATION (3-9)
 510. (RL ST) TOPICS IN MEDIEVAL CHURCH HISTORY (3 per semester, maximum of 6) Institutional and doctrinal development of the Christian church in medieval Europe.
 511. TOPICS IN MEDIEVAL BRITAIN (3 per semester, maximum of 6) Readings and research in major themes of the history of medieval Britain.
 515. EARLY MODERN EUROPE (3-6) A graduate seminar examining selected topics in early modern European history through readings, discussions, and research papers.
 516. (WMNST) TOPICS IN GENDER HISTORY (3) A critical analysis of gender and theories of gender in selected historical contexts.
 517. STUDIES IN MODERN EUROPEAN SOCIAL HISTORY (3-6) A graduate seminar examining the literature and methodologies of European social history since 1750 through readings, discussions, and research papers.
 518. TOPICS IN MODERN GERMAN HISTORY (3 per semester, maximum of 6) Readings and research in the history of Germany since 1740.
 520. STUDIES IN TWENTIETH-CENTURY EUROPE (3-6)
 522. STUDIES IN MODERN EUROPEAN INTELLECTUAL HISTORY (3-6) A seminar examining developments in modern European intellectual history through readings, class discussions, and research papers.
 523. TWENTIETH CENTURY THEORIES OF HISTORY (3) Studies in twentieth-century theories of history and historical methods.
 528. TOPICS IN MODERN EUROPEAN DIPLOMATIC HISTORY (3 per semester, maximum of 6) Readings and research in European diplomatic history since the Congress of Vienna.
 529. METHODS IN MODERN SOCIAL HISTORY (3 per semester, maximum of 6) Sources, interpretations, research methods, and current debates in modern social history.
 530. METHODS IN THE HISTORY OF SCIENCE AND TECHNOLOGY (3 per semester, maximum of 6) Modern research methods and historiographical controversies in the history of science and technology.
 533. STUDIES IN RUSSIAN AND SOVIET HISTORY (3-6)
 537. STUDIES IN BRITISH HISTORY (3-6)
 538. TOPICS IN RURAL HISTORY (3 per semester, maximum of 9) Historical analysis of rural societies, including cultural patterns, agricultural practices, social structures, environmental issues; research methodologies.

539. TOPICS IN MILITARY HISTORY (3 per semester, maximum of 9) Studies in the history of wars and of the political, social, economic, diplomatic, and theoretical foundations of warfare.
540. STUDIES IN COLONIAL AND REVOLUTIONARY AMERICA (3-6)
543. TOPICS IN ANTEBELLUM AMERICA (3 per semester, maximum of 6) Social, intellectual, and cultural developments from the period after the nation's founding until the start of the Civil War.
544. TOPICS IN THE CIVIL WAR AND RECONSTRUCTION (3 per semester, maximum of 6) Background and impact of the Civil War and the two succeeding decades, with emphasis on historiography and selected topics.
545. TOPICS IN GILDED AGE AND PROGRESSIVE ERA AMERICA, 1877-1919 (3 per semester, maximum of 6) Social, political, economic, and cultural history of the United States from the Gilded Age through Progressivism and World War I.
546. TOPICS IN UNITED STATES HISTORY SINCE 1919 (3 per semester, maximum of 6) Readings and research in major themes of the history of the United States in the twentieth century.
548. TOPICS IN THE UNITED STATES SOUTH (3 per semester, maximum of 6) Major themes of southern United States history.
549. TOPICS IN AFRICAN AMERICAN HISTORY (3 per semester, maximum of 6) Readings, research, and methods in the study of African American history.
550. STUDIES IN CONSTITUTIONAL HISTORY (3-9) A graduate seminar examining constitutional developments in their historical context through readings, class discussions, and research papers.
553. DIPLOMATIC HISTORY OF THE UNITED STATES (3-6)
555. (L I R) TOPICS IN AMERICAN LABOR HISTORY (3 per semester, maximum of 6) American working-class experience from its artisanal and agricultural roots through the rise, maturation, and transformations of industrial capitalism.
559. CULTURAL HISTORY OF THE UNITED STATES (3-6)
560. (RL ST) TOPICS IN AMERICAN RELIGION (3 per semester, maximum of 6) The social, political, and intellectual contexts of American religious thought.
561. (RL ST) TOPICS IN WESTERN RELIGION (3 per semester, maximum of 6) Major issues and themes in the historical development of Christianity and Judaism.
562. (RL ST) TOPICS IN COMPARATIVE RELIGION (3 per semester, maximum of 6) Comparative studies of world religions.
563. (RL ST) RELIGION AND SOCIETY (3 per semester, maximum of 6) Social and political implications of religious belief and practice.
564. TOPICS IN ASIAN RELIGIONS (3 per semester, maximum of 6) Topics in Asian religion.
565. (RL ST) RESEARCH IN RELIGIOUS STUDIES (3) Approaches and methodologies in the critical study of religion.
566. (RL ST) ISLAMIC STUDIES (3) Studies in Islamic history, historiography, theology, law and religious life.
569. SEMINAR IN LATIN AMERICAN HISTORY (3-6)
573. STUDIES IN MIDDLE EASTERN HISTORY (3-6)
583. TOPICS IN TRADITIONAL EAST ASIAN HISTORY (3 per semester, maximum of 6) Critical examination of historiography, and methodological and interpretive approaches in traditional East Asian history.
584. TOPICS IN MODERN EAST ASIAN HISTORY (3 per semester, maximum of 6) Research and readings in the history of East Asia since the early nineteenth century.
587. TOPICS IN MODERN SOUTH ASIAN HISTORY (3 per semester, maximum of 6) Research and readings in the history of South Asia since the late eighteenth century.
591. ARCHIVES PRACTICUM (3-6) Training and supervised work experience in archival activities—Option A: Archival Management; Option B: Oral History. Prerequisite: HIST (L ST) 490.
592. PROSEMINAR (3-9) Readings in fundamental historical works; different sections will treat such topics as United States history and early modern history.
595. INTERNSHIP (1-12) Supervised off-campus, nongroup instruction, including field experiences, practicums, or internships. Written and oral critique of activity required. Prerequisite: prior written approval of proposed assignment by instructor.
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

HORTICULTURE (HORT)

DENNIS R. DECOTEAU, *Head of the Department*
102 Tyson Building
814-865-2571

Degrees Conferred: Ph.D., M.S., M.Agr.

The Graduate Faculty

Richard N. Arteca, Ph.D. (Washington State) *Professor of Horticultural Physiology*
Cynthia L. Barden, Ph.D. (Massachusetts) *Assistant Professor of Postharvest Physiology*
David J. Beattie, Ph.D. (Michigan State) *Associate Professor of Ornamental Horticulture*
Robert D. Berghage, Ph.D. (Michigan State) *Assistant Professor of Horticulture*
Kathleen B. Brown (formerly Evensen), Ph.D. (Florida) *Associate Professor of Postharvest Physiology*
Richard Craig, Ph.D. (Penn State) *Professor of Plant Breeding and J. Franklin Styer Professor of Horticultural Botany*
Robert M. Crassweller, Ph.D. (Ohio State) *Professor of Tree Fruit*
David M. Eissenstat, Ph.D. (Utah) *Associate Professor of Woody Plant Physiology*
Majid R. Foolad, Ph.D. (California, Davis) *Assistant Professor of Plant Genetics*
David M. Glenn, Ph.D. (Oregon State) *Adjunct Professor of Horticulture*
Barbara L. Goulart, Ph.D. (Ohio State) *Associate Professor of Horticulture*
George M. Greene II, Ph.D. (Penn State) *Associate Professor of Pomology*
Mark J. Guiltinan, Ph.D. (California, Irvine) *Associate Professor of Plant Molecular Biology*
Charles W. Heuser, Ph.D. (Rutgers) *Associate Professor of Horticultural Physiology*
E. Jay Holcomb, Ph.D. (Penn State) *Professor of Floriculture*
Roger T. Koide, Ph.D. (California, Berkeley) *Professor of Horticultural Ecology*
Larry J. Kuhns, Ph.D. (Ohio State) *Professor of Ornamental Horticulture*
William J. Lamont, Jr. Ph.D. (Cornell) *Associate Professor of Vegetable Crops*
Jonathan P. Lynch, Ph.D. (California, Davis) *Associate Professor of Plant Nutrition*
Michael D. Orzolek, Ph.D. (Maryland) *Professor of Vegetable Crops*
James C. Sellmer, Ph.D. (Wisconsin-Madison) *Assistant Professor of Ornamental Horticulture*
Jack C. Shannon, Ph.D. (Illinois) *Professor of Plant Physiology*
Dennis J. Wolnick, Ph.D. (Penn State) *Associate Professor of Floriculture*

Students may specialize in crop production and marketing, integrated crop management, plant genetics and breeding, horticultural plant physiology, postharvest physiology, plant molecular biology and biotechnology, and horticultural ecology.

Admission Requirements

Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of the graduate program officer, a student may be admitted provisionally for graduate study in a program without these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Prerequisites for admission vary according to the area of specialization, but basic courses in physical sciences, mathematics, biological sciences, communication skills, and social sciences and humanities are required. Students who lack prerequisite courses may be admitted but are required to make up deficiencies without degree credit.

Students with a 2.75 junior/senior average (on a 4.00 scale) and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students.

Master's Degree Requirements

All M.Agr. candidates must present one seminar (HORT 590) and an acceptable paper on a selected professional problem, or a report of internship training. Up to 3 graduate credits will be given for an acceptable paper. The candidate may be required to provide one or more copies of the paper for the University. All M.S. degree candidates must complete at least one graduate course in biometry, at least 2 credits of resident or extension education (HORT 596 or 602), and two seminars (HORT 590). A thesis is required for the M.S. degree.

Doctoral Degree Requirements

The communication requirement for the Ph.D. degree may be satisfied by completing at least 6 graduate credits in an area of communications skills approved by the student's advisory committee.

All Ph.D. candidates must present at least three seminars (HORT 590) for credit and complete at least two graduate courses in statistics or statistical applications. Ph.D. students must take 2 credits of resident or extension education (HORT 596 or 602).

The candidacy examination must be taken within six months after beginning residency.

Within one semester after passing the candidacy examination, the student's doctoral committee, with the thesis adviser in charge, will have the program planning meeting. The purposes of this meeting are to (1) determine the student's strengths and weaknesses in pertinent subject matter areas; (2) guide the student in developing a plan of study; and (3) review and discuss the proposed thesis research.

The comprehensive examination, composed of both written and oral parts, will be given when, in the student's and adviser's opinion, the student is ready for the examination, and when the communication requirements and essentially all courses have been completed.

After the thesis is completed and all other requirements for the Ph.D. have been met, the dean of the Graduate School will schedule the final examination. Normally, three months must elapse between the comprehensive and the final examinations. A major part of the examination will be an oral defense of the thesis.

Student Aid

Fellowships, traineeships, graduate assistantships, and other forms of financial aid are described in the STUDENT AID section of the *Graduate Bulletin*. Students who wish to compete for fellowships should be sure that their application materials are complete by January 15 for entry the following fall semester.

The following award typically has been available to graduate students in this program:

WALTER THOMAS MEMORIAL SCHOLARSHIP—Available to students studying the nutrition of horticultural crops; stipend equivalent to a half-time assistantship. Apply through the Department of Horticulture.

HORTICULTURE (HORT)

402W. PLANT NUTRITION (3)

407. PLANT BREEDING (3)

412W. POSTHARVEST PHYSIOLOGY (3)

420. PLANT GROWTH REGULATORS (3)

431. SMALL FRUIT CULTURE (3)

432. DECIDUOUS TREE FRUITS (3)

433. VEGETABLE CROPS (3)

440W. PLANT-WATER RELATIONS (3)

444. ADVANCED PLANT BREEDING (4)

445. PLANT ECOLOGY (3)

450. GREENHOUSE MANAGEMENT (3)

453. FLOWER CROP PRODUCTION AND MANAGEMENT (3)

455. RETAIL HORTICULTURE BUSINESS MANAGEMENT (3)

464. LANDSCAPE CONSTRUCTION I (4)

466. LANDSCAPE CONSTRUCTION II (5)

468. LANDSCAPE ESTIMATING AND BIDDING (2)

469. (BIOTC) PLANT TISSUE CULTURE METHODS (3)

490. SENIOR SEMINAR (1)

495. INTERNSHIP (1-13)

496. INDEPENDENT STUDIES (1-18)

497, 498. SPECIAL TOPICS (1-9)

504. PHYSICS AND MANAGEMENT OF THE GREENHOUSE ENVIRONMENT (3) Evaluation of plant growth and development in an enclosed environment from both physiological and structural perspectives.

505. PLANT MOLECULAR AND EVOLUTIONARY CYTOGENETICS (3) Variations in plant chromosome structure, form, number, transposons, transgenic insertions. Organellar genetics. Effects on heredity, evolution, breeding. Prerequisite: BIOL 222.

514. (PLPHY) MODERN TECHNIQUES AND CONCEPTS IN PLANT ECOPHYSIOLOGY (2) An intensive introduction to concepts of plant ecophysiology and modern techniques used in this field. Prerequisite: BIOL 220W.

HOTEL, RESTAURANT, AND INSTITUTIONAL MANAGEMENT

520. ADVANCED PLANT GROWTH REGULATORS (2) Advanced topics in plant growth regulators, their chemical and physical properties; physiological, biochemical, and molecular regulation of plant growth and development. Prerequisite: HORT 420.

524. EXPERIMENTAL PROCEDURES IN PLANT SCIENCE RESEARCH (3) Experimental methods, computer techniques, interpretation of statistical analyses, and communication of research results. Prerequisite: AGRO 512 or 3 credits in 400-level statistics.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

HOTEL, RESTAURANT, AND INSTITUTIONAL MANAGEMENT (HR&IM)

WILLIAM P. ANDREW, *Professor in Charge*

201-H Mateer Building

814-863-0272

Degree Conferred: M.H.R.I.M.

The Graduate Faculty

William P. Andrew, Ph.D. (Penn State) *Associate Professor of Hotel, Restaurant, and Institutional Finance*

Frederick J. DeMicco, Ph.D. (Virginia Polytechnic) *Associate Professor of Hotel, Restaurant, and Institutional Management*

Peter B. Everett, Ph.D. (North Carolina) *Associate Professor of Marketing*

Angela Farrar, Ph.D. (Virginia Polytechnic) *Assistant Professor of Hotel, Restaurant, and Institutional Management*

Larry D. Gamm, Ph.D. (Iowa) *Associate Professor of Health Administration*

Carolyn U. Lambert, Ph.D. (Tennessee) *Associate Professor of Food Service Administration*

Daniel Mount, D.B.A. (U.S. International U) *Assistant Professor of Hotel, Restaurant, and Institutional Management*

Sara J. Parks, R.D., M.B.A. (Michigan State) *Associate Professor of Dietetics*

Elwood L. Shafer, Ph.D. (SUNY, Syracuse) *Professor of Hotel, Restaurant, and Institutional Management*

Richard W. St. Pierre, Ed.D. (North Carolina) *Professor of Health Education*

Helen S. Wright, Ph.D. (Penn State) *Professor of Nutrition*

The graduate program in Hotel, Restaurant, and Institutional Management (HR&IM) is an innovative, dynamic, and challenging graduate course of study for hospitality industry professionals who want to gain advanced hospitality management skills and knowledge. The program focuses on functional and conceptual aspects of hospitality management with a cutting-edge focus on their application to the hospitality industry. The development and enhancement of individual leadership, team building, and problem-solving skills is an integral part of this program. (*See also* MAN-ENVIRONMENT RELATIONS.)

Admission Requirements

Entry into the program requires a baccalaureate degree from an accredited institution as well as a minimum of two years of managerial work experience in the hospitality industry.

Scores for the Graduate Record Examination (GRE), Graduate Management Aptitude Test (GMAT), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School are required for admission. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Students with a 3.00 junior/senior grade-point average (on a 4.00 scale) will be considered for admission. Exceptions to this minimum average are sometimes made for students with special backgrounds, abilities, interests, and circumstances. Students are expected to have managerial competency in accounting, marketing, economics, human resource management, management information systems, and computer technology prior to entry into the program. Deficiencies in any of these areas must be made up in the first year that the student is enrolled (and will not be counted toward the program's 36-credit requirement).

Master's Degree (MHRIM) Requirements

Students must complete a core of seven courses (HR&IM 500, 535, 542, 550, 565, 570, and 3 credits in International Hospitality Management). In addition, students must take a minimum of 3 credits of HR&IM 590 Colloquium. Students also complete a 9-credit directed elective sequence designed to build a focus in a specific hospitality management area.

A master's project and paper is required of all students. This hands-on industry problem-solving project and paper requires student interaction with actual hospitality firms and institutions.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

HOTEL, RESTAURANT, AND INSTITUTIONAL MANAGEMENT (HR&IM)

- 402. EQUIPMENT, LAYOUT, AND DESIGN OF HOSPITALITY OPERATIONS (3)
- 405. LEGAL ASPECTS OF THE HOSPITALITY INDUSTRY (3)
- 410. ADVANCED QUANTITY FOOD PRODUCTION (2-5)
- 411. BEVERAGE MANAGEMENT AND WINE SELECTION (3)
- 412. ADVANCED INSTITUTIONAL FOOD SERVICE MANAGEMENT (4)
- 414. HOTEL FOOD AND BEVERAGE MANAGEMENT (3)
- 415. INTERNATIONAL CUISINE (3)
- 430. ADVANCED FOOD SERVICE MANAGEMENT LABORATORY (3)
- 435. FINANCIAL MANAGEMENT IN HOSPITALITY OPERATIONS (3)
- 436. HOSPITALITY OPERATIONAL MANAGEMENT (3)
- 437. HOSPITALITY PROJECT EVALUATION AND FUNDING (3)
- 438. CASES IN FINANCIAL ANALYSIS (3)
- 442. HOSPITALITY MARKETING (3)
- 443. SALES PLANNING AND ADVERTISING FOR HOSPITALITY OPERATIONS (3)
- 444. CARIBBEAN HOSPITALITY/TOURISM DEVELOPMENT (3)
- 455. CONVENTION MANAGEMENT (3)
- 456. CASINO OPERATIONS MANAGEMENT (3)
- 466. HUMAN RESOURCE MANAGEMENT IN THE HOSPITALITY INDUSTRY (3)
- 467. MANAGEMENT OF HOTEL AND RESTAURANT EMPLOYEE RELATIONS (3)
- 489. SEMINAR IN INSTITUTIONAL FOOD SERVICE MANAGEMENT (3)
- 490. STRATEGIC HOSPITALITY MANAGEMENT (3)
- 491. OPERATIONAL ANALYSIS OF INSTITUTIONAL FOOD SERVICE (3)
- 492. ADVANCED PROFESSIONAL SEMINAR IN HOTEL, RESTAURANT, AND INSTITUTIONAL MANAGEMENT (1)
- 495. HOTEL INTERNSHIP (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
- 500. STRATEGIC PLANNING IN THE HRI INDUSTRY (3) The development of plans for hospitality operations, emphasizing the interrelationships of the services, financial, marketing, and human resource subsystems.
- 501. CURRENT ISSUES IN HRIM (3) Seminar focusing on contemporary issues impacting on the hospitality industry.
- 502. HRI FACILITIES PLANNING AND DESIGN (3) The planning, design, evaluation, and management of the physical plant of an HRI facility.
- 503. METHODS FOR HRI RESEARCH (3) An introduction to the process of research. Problem-solving approaches. The research proposal and the development of the research question.
- 525. INSTITUTIONAL FOOD SERVICE MANAGEMENT (3) The development of a working comprehension and integration of the institutional management into the HRI field.
- 535. HRI FINANCIAL ADMINISTRATION AND POLICY (3) The development of financial concepts and application relevant to HRI firm management and policy.
- 542. RESEARCH METHODS IN HRI MARKETING (3) Identification and use of research techniques appropriate to marketing management decision making.

550. QUANTITATIVE MODELING AND DECISION MAKING IN THE HRI INDUSTRY (3) Development and solution of mathematical models for decision making in HRI and other service industries.
565. HUMAN RESOURCE PROBLEMS IN THE HRI INDUSTRY (3) In-depth study of topics in human resource management for the HRI industry focusing on planning, organization, selection, appraisal, and legal aspects.
570. MANAGEMENT OF HRI SERVICE SYSTEMS (3) Management of domestic and international multiunit HRI service organizations.
590. (1–3 per semester, maximum of 3) COLLOQUIUM
596. INDIVIDUAL STUDIES (1–9)
597. SPECIAL TOPICS (1–9)

HUMAN DEVELOPMENT AND FAMILY STUDIES (HD FS)

LEANN BIRCH, *Department Head, Human Development and Family Studies*
S-211 Henderson Building
814-863-0241

ANN CROUTER
S113C Henderson Building
814-865-2647

and
SUSAN McHALE
S113 B Henderson Building
814-865-2663

In Charge of Graduate Programs in Human Development and Family Studies

Degrees Conferred: Ph.D., M.S.

(A master's degree is offered only to persons interested in studying for a doctorate.)

The Graduate Faculty

Kathleen Barry, Ph.D. (California, Berkeley) *Associate Professor of Human Development*
Jay Belsky, Ph.D. (Cornell) *Distinguished Professor of Human Development*
Leann Birch, Ph.D. (Michigan) *Professor of Human Development*
Timothy Blackson, Ph.D. (Pittsburgh) *Senior Research Associate in Human Development and Family Studies*
Alan Booth, Ph.D. (Nebraska—Lincoln) *Professor of Human Development and Sociology*
Robert L. Burgess, Ph.D. (Washington—St. Louis) *Professor of Human Development*
Linda M. Burton, Ph.D. (Southern California) *Professor of Human Development and Sociology*
Catherine Cohan, Ph.D. (UCLA) *Assistant Professor of Human Development and Family Studies*
Linda Collins, Ph.D. (USC) *Professor of Human Development and Family Studies*
Sherry Corneal, Ph.D. (Penn State) *Assistant Professor of Human Development*
Ann C. Crouter, Ph.D. (Cornell) *Professor of Human Development*
Nancy Darling, Ph.D. (Cornell) *Assistant Professor of Human Development and Family Studies*
Anthony R. D'Augelli, Ph.D. (Connecticut) *Professor of Human Development*
Judith F. Dunn, Ph.D. (Cambridge) *Adjunct and Distinguished Professor of Human Development*
Eric H. Durbrow, Ph.D. (Missouri) *Assistant Professor of Human Development and Family Studies*
Craig Edelbrock, Ph.D. (Oregon State) *Professor of Human Development and Family Studies and Biobehavioral Health*
David J. Eggebeen, Ph.D. (North Carolina) *Associate Professor of Human Development*
Lynne Vernon-Feagans, Ph.D. (Michigan) *Professor of Human Development*
Karen Fingerman, Ph.D. (Michigan) *Assistant Professor of Human Development and Family Studies*
Donald H. Ford, Ph.D. (Penn State) *Professor Emeritus of Human Development*
Paul A. Games, Ph.D. (Iowa) *Professor Emeritus of Human Development*
Mark T. Greenberg, Ph.D. (Virginia) *Professor and Edna Peterson Bennett Endowed Chair*
Bernard G. Guerney, Jr., Ph.D. (Penn State) *Professor Emeritus of Human Development and Counseling Psychology*
Louise F. Guernsey, Ph.D. (Penn State) *Professor Emerita of Human Development and Family Studies and Counseling Psychology*
Sara Harkness, Ph.D. (Harvard) *Adjunct and Associate Professor of Human Development*

- Kathryn Hood, Ph.D. (Temple) *Associate Professor of Human Development*
 Janis Jacobs, Ph.D. (Michigan) *Associate Professor of Human Development and Family Studies and Psychology*
 Rukmalie Jayakody, Ph.D. (Michigan) *Assistant Professor of Human Development and Family Studies*
 Elizabeth E. Manlove, Ph.D. (Penn State) *Assistant Professor of Human Development and Family Studies*
 Susan M. McHale, Ph.D. (North Carolina) *Professor of Human Development*
 Gordon K. Nelson, Ph.D. (Wisconsin) *Associate Professor of Human Development*
 Judith L. Newman, Ph.D. (Temple) *Associate Professor of Human Development*
 Andrea M. Piccinin, Ph.D. (Southern California) *Assistant Professor of Human Development and Family Studies*
 Robert Plomin, Ph.D. (Texas) *Adjunct Professor of Human Development and Family Studies*
 Michael Rovine, Ph.D. (Penn State) *Associate Professor of Human Development*
 Aline Sayer, Ed.D. (Harvard) *Assistant Professor of Human Development and Family Studies*
 K. Warner Schaie, Ph.D. (Washington) *Evan Pugh Professor of Human Development and Psychology*
 Michael Shanahan, Ph.D. (Minnesota) *Assistant Professor of Human Development and Family Studies*
 Rainer Silbereisen, Ph.D. (Jena) *Adjunct Professor of Human Development and Family Studies*
 Edward Smith, Ph.D. (North Carolina) *Associate Professor of Human Development and Family Studies*
 Graham Spanier, Ph.D. (Northwestern) *Professor of Human Development and Family Studies, Sociology, and Family and Community Medicine*
 Cynthia A. Stifter, Ph.D. (Maryland) *Associate Professor of Human Development*
 Stephen J. Suomi, Ph.D. (Wisconsin) *Adjunct Professor of Human Development*
 Charles M. Super, Ph.D. (Harvard) *Adjunct Professor of Human Development and Family Studies*
 Fred W. Vondracek, Ph.D. (Penn State) *Professor of Human Development*
 Sherry L. Willis, Ph.D. (Texas) *Professor of Human Development*
 Steven H. Zarit, Ph.D. (Chicago) *Professor of Human Development*

This interdisciplinary graduate program in the College of Health and Human Development is administered through the Department of Human Development and Family Studies. It focuses on the developmental study of individuals, small groups, and families for the purposes of expanding basic knowledge and professional application. The perspective encompasses the individual life span, from infancy and childhood through later maturity and old age, as well as the full cycle of the family. For both individual and family, the perspective includes variations in functioning patterns and the use of resources; the impact of diverse social, economic, and cultural contexts upon behavior; conditions that promote adaptive individual, group, and family development; and the creation of techniques of accomplishing human development. Emphasis is upon the integration of knowledge from various fields for understanding and developing skills for careers in research and scholarship, teaching, program planning and evaluation, and other professional services. The faculty includes persons primarily in the behavioral and social sciences particularly committed to research and application in these multi- and interdisciplinary areas.

The student's program is expected to include work assuring both breadth in the major field and depth within one of three program areas: family development, human development intervention, or individual development. Further specialization is possible in adult development and aging, biological bases of behavior, child and adolescent development, cognitive development and functioning, early childhood services, family economics and management, family relationships, integrative theories of human development, interpersonal relationships, developmental methodology, and social-emotional development and change.

The Child Development/Child Services Laboratory is operated as part of the teaching and research program. Each of three units has observational facilities and rooms for study of individual and group behavior of children and adults. The Individual and Family Consultation Center provides facilities for the development and evaluation of educational programs for remediation of individual and family problems by professional and paraprofessional persons. The Center for the Study of Child and Adolescent Development and the Gerontology Center provide opportunities for participation in research and evaluation projects. Additional resources are available in other parts of the University.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are required for admission. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Entering students should have at least 6 credits in the biological and physical sciences; 12 in the social sciences and, depending upon proposed area of emphasis, basic courses in sociology, psychology, and economics; and 6 in developmental and family studies. Students not meeting these requirements may be admitted with limited deficiencies to be made up concurrently with their graduate work.

Students with a 3.00 junior/senior average (on a 4.00 scale) and with appropriate course backgrounds will be considered for admission for fall semester only. Early application is required, and a special application to HD FS must be completed; additional information can be obtained from the professor in charge of Graduate Recruitment and Interdisciplinary Training. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

Degree Requirements

All students must take a two-semester introduction to the fundamental philosophical, theoretical, methodological, and professional issues in the study of human development. In addition, master's students must take a 6-credit research and evaluation methodology core, and Ph.D. students must take an 18-credit research and evaluation methodology core. Twelve of these credits are courses taken by all Ph.D. students. The other 6 credits may be satisfied by selections from a variety of courses. Master's students must also take a minimum of 12 credits in course work (400 and 500 level), 9 of which must be in HD FS (excluding independent study). Ph.D. students must take a minimum of 15 credits in course work (400 and 500 level) in HD FS (excluding independent study). Use may be made also of courses in other parts of the college and University to build substantive competence in the program. The communication and foreign language requirement for the Ph.D. degree may be satisfied by options selected from designated areas including, but not restricted to, foreign languages.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

HUMAN DEVELOPMENT AND FAMILY STUDIES (HD FS)

- 401. PROJECT PLANNING, IMPLEMENTATION, AND EVALUATION IN THE HUMAN SERVICES (3)
- 402. HUMAN SERVICES SEMINAR (4)
- 405. GENDER AND SOCIAL DEVELOPMENT (3)
- 410. COMMUNITIES AND FAMILIES (3)
- 411. THE HELPING RELATIONSHIP (3)
- 412. ADULT-CHILD RELATIONSHIPS (3)
- 413. DEVELOPMENTAL PROBLEMS IN ADULthood (3)
- 414. RESOLVING HUMAN DEVELOPMENT AND FAMILY PROBLEMS (3)
- 415. PROGRAM DEVELOPMENT IN FAMILY RELATIONSHIPS (3)
- 417. BIOCULTURAL STUDIES OF FAMILY ORGANIZATION (3)
- 418. FAMILY RELATIONSHIPS (3)
- 420. LABORATORY IN INDIVIDUAL AND FAMILY ENHANCEMENT (3)
- 424. FAMILY DEVELOPMENT IN AN ECONOMIC CONTEXT (3)
- 425. WORK AS A CONTEXT FOR HUMAN DEVELOPMENT (3)
- 428. INFANT DEVELOPMENT (3)
- 429. ADVANCED CHILD DEVELOPMENT (3)
- 430. EXPERIENCE IN PRESCHOOL GROUPS (6)
- 431. (SOC) FAMILY DISORGANIZATION
- 432. DEVELOPMENTAL PROBLEMS IN CHILDHOOD AND ADOLESCENCE (3)
- 433. DEVELOPMENTAL TRANSITION TO ADULthood (3)
- 434. SOCIAL GERONTOLOGY (3)
- 445. (PSY) DEVELOPMENT THROUGHOUT ADULthood (3)
- 446. PROGRAMS AND SERVICES IN GERONTOLOGY (3)
- 447. ISSUES IN GERONTOLOGY (3)
- 450. DEVELOPMENTAL CHILD PROGRAMS AND SERVICES (3)
- 453. FAMILY PARTICIPATION AND INVOLVEMENT IN CHILD SERVICES (3)
- 454. (E C E) DEVELOPMENT AND ADMINISTRATION OF CHILD SERVICE PROGRAMS (3)
- 455. DEVELOPMENT AND ADMINISTRATION OF HUMAN SERVICES PROGRAMS (3)
- 468. BIOLOGICAL BASES OF BEHAVIORAL DEVELOPMENT (3)
- 477. ANALYSIS OF FAMILY PROBLEMS (2-9)
- 490. INTRODUCTION TO FIELD EXPERIENCE (2)
- 495A. INTERNSHIP: ADVANCED EXPERIENCE (8)
- 495B. INTERNSHIP: ADVANCED PROJECT (4)

495C. PROFESSIONAL PRACTICUM IN HUMAN SERVICES (3–8)

496. INDEPENDENT STUDIES (1–18)

497, 498. SPECIAL TOPICS (1–9)

500. NONTHESIS RESEARCH (1–9)

501. SEMINAR: ISSUES IN THE STUDY OF INDIVIDUAL AND FAMILY DEVELOPMENT

(1–3) Reading, reports, and discussion of conceptual frameworks for multidisciplinary and developmental study of individuals and families.

503. HUMAN DEVELOPMENT INTERVENTION: ANALYSIS OF THEORIES AND APPROACHES

(3) Theoretical and empirical analyses of multilevel approaches for enhancing development of individuals and families. Prerequisite: graduate status in HD FS or related fields; first in a sequence.

504. CONSULTATION IN HUMAN DEVELOPMENT INTERVENTION (3) Principles of consultative and collaborative practice with human development intervention programs in formal or informal community settings. Prerequisite: HD FS 503.

505. ASSESSMENT IN HUMAN DEVELOPMENT (3) Overview of methods and procedures used for the assessment of families and the development of individuals across the lifespan. Prerequisite: at least one course in measurement, test construction, or assessment.

506. PROJECTS IN DESIGN AND EVALUATION OF PROGRAMS FOR PRESCHOOL CHILDREN

(2–4) Individual projects in the design, implementation, and evaluation of different teaching approaches with varying groups of children. Prerequisites: HD FS 504 and 3 credits in research methods.

507. FEMINIST THEORY (3) Development of feminist theory and its relationship to history in terms of critique of family, sexuality, and gender stratification.

508. PARENTAL EDUCATION (1–6) Implementing education and preventive programs for parents; discussion and evaluation of theory and techniques.

509. NATURE-NURTURE INTERACTIONS IN HUMAN DEVELOPMENT (3) Introduction to nature-nurture interactions in lifespan development; biological, psychological, and cultural factors on ontogeny and phylogeny.

511. (CNPSY) MODIFYING CONJUGAL LIFE (1–9) Conceptual foundations, research procedures, and practicum experience in teaching effective communication and problem-solving skills in the marriage relationship. Prerequisites: 6 credits in individual development or psychology and 3 credits in statistics.

512. (CNPSY) FILIAL RELATIONSHIP MODIFICATION (1–9) Theory, research, practicum in teaching parents to resolve developmental problems in their own children. Prerequisites 6 credits in individual development or psychology and 3 credits in statistics.

515. TEACHING INDIVIDUAL DEVELOPMENT AND FAMILY STUDIES (1–6) Objectives, techniques, materials, and evaluation in teaching at the secondary and college level, and in adult and public education programs.

517. (H DEV) MULTIVARIATE STUDY OF CHANGE AND HUMAN DEVELOPMENT (3) Models of development and change derived from empirical research utilizing multivariate research design and procedures. Prerequisite: at least three statistics courses, including correlation and regression analysis.

519. METHODS OF STATISTICAL ANALYSIS IN HUMAN DEVELOPMENT (3) An overview of basic statistical concepts, models, and methods for the analysis of development and change. Prerequisites: H DEV 516, introductory statistics.

520. SEMINAR IN PRENATAL AND INFANT DEVELOPMENT (1–6) Prenatal and infant development, with emphasis on multiple determinants of early development and their relationship to later behavior. Prerequisites: 6 graduate credits in individual development, psychology, or biological science and 3 credits in statistics.

521. QUALITATIVE METHODS IN HUMAN DEVELOPMENT AND FAMILY STUDIES (3) Introduction to interdisciplinary qualitative methods, principles, and theory of interpretation, methodologies, data collection and analysis.

522. SEMINAR IN DYSFUNCTION PROCESS IN INDIVIDUAL DEVELOPMENT (1–6) Multiple processes involved in dysfunctional development in the individual across the life span. Prerequisite: HD FS 413.

523. STRATEGIES FOR DATA ANALYSIS IN DEVELOPMENTAL RESEARCH (3) This course provides the skills necessary to confront the data analytic issues presented in the Human Development and Family Studies methodology core curriculum. Prerequisite: HD FS 519 or STAT 501.

524. THEORETICAL ANALYSIS OF FAMILY ECONOMIC AND MANAGERIAL BEHAVIOR (3) Conceptual approaches and major contributions to the study of the organizational, managerial, and economic functions of the family. Prerequisite: HD FS 418, 424, or 477.

525. THEORIES OF FAMILY RELATIONSHIPS (3) Assessment of the utility of major theories for empirical analysis of interpersonal interactions among family members. Prerequisite: HD FS 418.

HUMANITIES

526. (PSY) MEASUREMENT IN HUMAN DEVELOPMENT (3) Principles and methods for assessment of human developmental processes across the life span. Prerequisites: EDPSY 450 or PSY 450; H DEV 516, HD FS 519.

528. OBSERVATIONAL METHODOLOGIES FOR DEVELOPMENT (3) Design and application of observational methods in developmental research,. Prerequisite: graduate student standing in HD FS or psychology.

529. (PSY) SEMINAR IN CHILD DEVELOPMENT (1-6) Readings and reports on recent findings in child development. Prerequisites: 6 graduate credits in child development, child psychology, or educational psychology, plus 3 credits in statistics.

531. (SOC) FAMILY DISORGANIZATION: STRESS POINTS IN THE CONTEMPORARY FAMILY (3) Focuses on divorce, remarriage, incest, family violence as well as problems associated with family formation and parent-child relations.

536. (PSY) RESEARCH METHODS IN DEVELOPMENTAL PROCESSES (3) Methodological issues in research on varying stages of development across the individual life span. Prerequisites: 6 credits in individual development or psychology and a course in statistics.

539. SEMINAR IN ADOLESCENT DEVELOPMENT (1-6) Cultural, psychological, and biological aspects of the developmental transition to adulthood. Prerequisites: 6 credits in individual development or psychology and 3 credits in sociology and statistics.

544. SEMINAR IN DYSFUNCTIONAL PATTERNS IN FAMILY ORGANIZATION (1-6) Processes of familial dysfunction and disorganization and their explanation in economic, social-psychological, and managerial terms. Prerequisite: HD FS 418 or 424 or SOC 430.

545. FAMILIES AND SOCIOECONOMIC SYSTEMS (1-6) Functional interrelationships between families and social and economic systems. Prerequisites: HD FS 418, 424.

546. SEMINAR IN FAMILY RELATIONSHIPS (1-9) Interpersonal interaction within family systems throughout the life cycle. Prerequisite: HD FS 418.

549. (PSY) DEVELOPMENTAL THEORY (3) Conceptual frameworks and major contributions to the study of individual development across the life span. Prerequisites: 6 credits at the 400 level in individual development or psychology.

565. DEVELOPMENTAL BEHAVIORAL GENETICS (3) Theories and methods of developmental behavioral genetics and their application to human life span development.

579. SEMINAR IN ADULT DEVELOPMENT AND AGING (1-9) A seminar dealing with specific topics concerning adult development and aging. Prerequisites: HD FS (PSY) 445, statistics.

590. COLLOQUIUM (1-3)

595. FIELD PROJECTS IN INDIVIDUAL AND FAMILY STUDIES (1-9) Supervised research or internship in human services program. Prerequisite: instructor's approval of proposed project.

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

HUMANITIES (HUMAN)

Coordinator, Humanities Graduate Program

Penn State Harrisburg

777 W. Harrisburg Pike

Middletown, PA 17057-4898

717-948-6189

Degree Conferred: M.A.

The Graduate Faculty

Michael L. Barton, Ph.D. (Pennsylvania) *Associate Professor of Social Science and American Studies*

Simon J. Bronner, Ph.D. (Indiana) *Distinguished Professor of Folklore and American Studies*

Charles R. Catalupo, Ph.D. (Rutgers) *Professor of English*

Eton F. Churchill, M.F.A. (Tulane) *Assistant Professor of Humanities and Communications*

Theodora R. Graham, Ph.D. (Pennsylvania) *Associate Professor of Humanities and English*

Hartmut Heep, Ph.D. (Illinois) *Associate Professor of German*

Alison Duncan Hirsch, Ph.D. (Columbia) *Assistant Professor of American Studies and History*

Louise E. Hoffman, Ph.D. (Bryn Mawr) *Associate Professor of Humanities and History*

Patricia E. Johnson, Ph.D. (Minnesota) *Associate Professor of Humanities and Literature*

William J. Mahar, Ph.D. (Syracuse) *Professor of Humanities and Music*

Glen Mazis, Ph.D. (Yale) *Associate Professor of Humanities and Philosophy*

John S. Patterson, Ph.D. (Brown) *Associate Professor of American Studies and History*

Irwin Richman, Ph.D. (Pennsylvania) *Professor of American Studies and History*
 Cheri L. Ross, Ph.D. (Purdue) *Assistant Professor of English Education and Humanities*
 Troy M. Thomas, Ph.D. (California) *Associate Professor of Humanities and Art*
 Crispin Sartwell, Ph.D. (Virginia) *Associate Professor of Humanities and Communications*
 Judith L. Stephens, Ph.D. (Kent State) *Assistant Professor of Speech Communications*
 Anita M. Vickers, Ph.D. (Purdue) *Assistant Professor of English*
 Victor J. Viser, Ph.D. (Temple) *Assistant Professor of Humanities and Communications*
 Matthew T. Wilson, Ph.D. (Rutgers) *Associate Professor of Humanities and Writing*
 George D. Wolf, Ph.D. (Pennsylvania) *Professor Emeritus of American Studies and History*
 Melvin H. Wolf, Ph.D. (Michigan) *Professor Emeritus of Humanities and English*

This program is interdisciplinary, emphasizing critical theories and interpretive approaches that transcend disciplinary boundaries as well as providing advanced study within various humanities disciplines. These include art history, communications, history, literature, music history, philosophy, and writing. The program offers small classes, individualized advising, and assistance in developing advanced analytical, synthetic, and interpretive skills. It accommodates both part-time and full-time students.

Admission Requirements

Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Applicants must hold a baccalaureate degree from an accredited college or university; have earned at least a 2.50 grade-point average in their junior and senior years; and have studied in two humanities disciplines (usually a major in one area and some course work in another). Exceptions may be made for those with special backgrounds or abilities who are committed to advanced interdisciplinary study. All applicants must submit the following items, preferably by March of the year in which they wish to begin study: an application form and fee; two copies of official transcripts from all colleges/universities attended; a letter explaining personal or career goals and reasons for wishing to enroll in the program; two letters of reference (preferably from previous professors or others familiar with the applicant's intellectual/creative work or interests); and a writing sample (an academic paper; if this is not available, consult the graduate coordinator for an alternative).

Students applying for fellowships or assistantships must submit scores from the Graduate Record Examination (GRE) or similar examination by January 15. An admissions committee often interviews applicants in person or by telephone. Applications must be received by November 1 for spring semester admission; by January 15 for applicants requesting financial aid for the following year; and by April 1 for summer and fall admission.

Degree Requirements

All students must complete 30 credits, 18 of which must be at the 500 level, achieve a 3.00 grade-point average, and successfully complete an interdisciplinary master's production (academic thesis or creative production with academic essay). Students work with their faculty advisers and supervisory committees to select courses in accordance with their individual interests.

Courses required of all students include HUM 500, a foundation course in research methods; HUM 560, a capstone course in interdisciplinary theory and research; and HUM 580, the master's production. (See course titles and descriptions in this section.) Recommended courses include HUM 525 Studies in Aesthetics, and HUM 535 Topics in Cultural and Intellectual History, both multidisciplinary courses, covering the content of various disciplines from the perspective of one discipline. To acquire breadth in the humanities, students must take at least one course in each of three disciplines; single-discipline courses are available as HUM 515 Seminar (repeatable for credit). Other courses in particular disciplines are available at the 400 level. Other available 500-level courses are listed in this section. Students planning to teach in a junior or community college may arrange a teaching internship (HUM 550), subject to appropriate preparation and approval by both the program and the community college.

A full-time student can expect to complete the program in four semesters, a part-time student in six or more semesters. Students are expected to complete all requirements for the degree within six years, although the deadline may be extended at the discretion of the graduate coordinator in accordance with policies approved by the Graduate School.

HUMANITIES (HUM)

Required Courses

500. RESEARCH METHODS AND SCHOLARLY INQUIRY IN THE HUMANITIES (3) Study of the methods and materials of scholarship, use of reference tools, evaluation of evidence, and writing of research papers.

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560. INTERRELATIONS IN THE HUMANITIES (3) The study and practice of conducting interdisciplinary research and of investigating and supporting inter-art analogies. Prerequisite: HUM 500; 21 credits.

580. MASTER'S PRODUCTION (1-6) An original scholarly master's paper or creative production initiated by the student, supervised by an appropriate professor, and judged by a committee.

Recommended Courses

525. STUDIES IN AESTHETICS (3) Philosophical investigation into the nature of art, aesthetic experience, artistic meaning, criticism, grounds for judgement, and history of aesthetic theory.

535. TOPICS IN CULTURAL AND INTELLECTUAL HISTORY (3) Study of methods, issues, and selected topics in the history of thought, social values, and creative expression.

Other Courses

502. ENGLISH COMPOSITION STUDIES (3) An overview of the field of composition studies with particular attention to the various schools of writing pedagogy.

515. SEMINAR (3 per semester, maximum of 9) A seminar focusing on typical methods and approaches of a single discipline within the humanities. (May be repeated for credit.)

Unit A. Art History (3) Study of sources and documents, style analysis, iconography, criticism, interpretation, and social context of art, within a selected chronological period.

Unit B. History. (3) Study of a particular historical period or theme, emphasizing critical use of sources, interpretive approaches, and theories.

Unit C. Literature (3) Study of a period, form, author, or idea and/or investigation of a fundamental problem in literary aesthetics or theory.

Unit D. Music History and Analysis (3) Study of a period, style, composer, or genre and/or investigation of problems in the aesthetics or history of music.

Unit E. Philosophy (3) Detailed investigation of a period of philosophy, e.g., ancient, contemporary, or of a fundamental problem, e.g., mind, language, ethics, logic.

Unit F. Communications (3) Study of an issue, genre, or development in media, their social/cultural context, or communications theory.

Unit G. Writing (3) Investigation and application of one or more genres or composition theory.

530. SEMINAR IN COMPARATIVE ARTS (3) A seminar focusing on selected periods or artists in two or more areas within the humanities.

550. JUNIOR COLLEGE TEACHING INTERNSHIP (3) Teaching humanities courses in a two-year college under a faculty supervisor who will direct, criticize, and evaluate the intern. (Credits not applicable toward graduation.)

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

Additional courses may be taken from the following list and at the 400- or 500-level in related fields with the concurrence of the student's adviser. See the *Penn State Harrisburg Bulletin* for course titles, credits, and descriptions.

AMSTD 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 469, 470, 480

C ART 415, 420, 425, 427, 428, 429, 430, 431, 440

HCOMM 434

ENLSH 402, 405

C HIS 405, 440, 460

HUM 409, 410, 420, 430, 453, 460, 461

LIT 415, 427, 429, 440, 445, 447, 450, 460, 470, 475, 477, 480, 482, 485, 487, 491

C MUS 427, 440, 460

PHLOS 415, 416, 417, 418, 431, 447, 490

THTRE 406

INDUSTRIAL ENGINEERING (I E)

A. Ravindran, *Head of the Department of Industrial and Manufacturing Engineering*
207 Hammond Building
814-865-7601

Degrees Conferred: Ph.D., M.S., M.Eng. (M.Eng. offered only at Penn State Great Valley)

The Graduate Faculty

Russell R. Barton, Ph.D. (Cornell) *Professor of Industrial Engineering*
 David J. Cannon, Ph.D. (Stanford) *Associate Professor of Industrial Engineering*
 Tom M. Cavalier, Ph.D. (Virginia Polytechnic) *Professor of Industrial Engineering*
 M. Jeya Chandra, Ph.D. (Syracuse) *Professor of Industrial Engineering*
 Paul H. Cohen, Ph.D. (Ohio State) *Professor of Industrial Engineering*
 Edward C. De Meter, Ph.D. (Virginia Polytechnic) *Associate Professor of Industrial Engineering*
 Enrique del Castillo, Ph.D. (Arizona State) *Associate Professor of Industrial Engineering*
 Ernest E. Enscoe, Jr., Ph.D. (Penn State) P.E. *Professor of Industrial Engineering*
 Andris Freivalds, Ph.D. (Michigan) *Professor of Industrial Engineering*
 Natarajan Gautam, Ph.D. (North Carolina State) *Assistant Professor of Industrial Engineering*
 Joseph H. Goldberg, Ph.D. (Michigan) *Associate Professor of Industrial Engineering*
 Catherine M. Harmonosky, Ph.D. (Purdue) *Associate Professor of Industrial Engineering*
 Sanjay Joshi, Ph.D. (Purdue) *Professor of Industrial Engineering*
 Eugene Kozik, Ph.D. (Pittsburgh) *Associate Professor of Industrial Engineering*
 El-Amine Lehtihet, Ph.D. (Lehigh) *Associate Professor of Industrial Engineering*
 John I. McCool, Ph.D. (Temple) *Associate Professor of Industrial Engineering*
 Deborah J. Medeiros, Ph.D. (Purdue) *Associate Professor of Industrial Engineering*
 Vittal Prabhu, Ph.D. (Wisconsin) *Assistant Professor of Industrial Engineering*
 A. Ravindran, Ph.D. (Berkeley) *Professor of Industrial Engineering*
 Clayton O. Ruud, Ph.D. (Denver) P.E. *Professor of Industrial Engineering*
 Timothy W. Simpson, Ph.D. (Georgia Tech) *Assistant Professor of Industrial Engineering and Mechanical Engineering*
 Soundar R. Tirupatikumara, Ph.D. (Purdue) *Professor of Industrial Engineering*
 Jose A. Ventura, Ph.D. (Florida) *Professor of Industrial Engineering*
 Robert C. Voigt, Ph.D. (Wisconsin) P.E. *Professor of Industrial Engineering*
 Richard A. Wysk, Ph.D. (Purdue) *Professor of Industrial Engineering*
 Xiang Zhang, Ph.D. (Berkeley) *Assistant Professor of Industrial Engineering*

Graduate study and research are conducted in manufacturing process, information engineering operations research-management science, production engineering, process design, systems engineering, human factors, ergonomics, and robotics.

Admission Requirements

Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission, at the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

To be admitted into the program, an applicant must have received a baccalaureate degree from an accredited institution. Graduates in engineering, physical sciences, and mathematics who present a 3.00 grade-point average will be considered for admission. For all international students whose native language is not English, scores from the Test of English as a Foreign Language (TOEFL) are required with a minimum score of 550 required for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

Degree Requirements

Three degrees are offered: the Master of Engineering (M.Eng.—offered only at Penn State Great Valley), the Master of Science (M.S.), and the Doctor of Philosophy (Ph.D.). For the M.Eng. degree, 27 credits of course work beyond the baccalaureate level are required, of which at least 15 credits must be from the department. At least 9 of the 15 credits must be at the 500 level. In addition, a paper, for which 3 credits of IE 596 may be used, is required of all candidates for the M.Eng. degree. For the M.S. degree, 24 credits of course work are required, of which at least 15 credits must be from the department. At least 9 of the 15 credits must be at the 500 level. In addition, a thesis, for which 6 credits may be used, also is required. For the M.S. degree with an option in Human Factors/Ergonomics Engineering, 30 credits of course work beyond the baccalaureate degree are required: 12 credits of Industrial Engineering core courses; 12 credits of electives; and 6 credits of thesis research. In addition to the above, all M.S. students are required to enroll for two IE colloquiums. For the Ph.D. degree, 30 credits of 500-level, six 400-level industrial engineering

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courses beyond the baccalaureate level and 9 technical credits from other departments are required. In addition to the above, all Ph.D. students are required to enroll for three I E colloquiums if entering with an M.S. and four I E colloquiums if entering with a B.S.

Continuous registration is required for all graduate students until the thesis is approved.

Other Relevant Information

Students in this program may elect the dual-title degree program in Operations Research for the Ph.D. and M.S. degrees.

Student Aid

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AID section of the *Graduate Bulletin*, the following award typically has been available to graduate students in this program:

BENJAMIN W. NIEBEL MANUFACTURING FELLOWSHIP—Consideration for this fellowship shall be given to all students exhibiting academic excellence who have been admitted to Penn State as candidates for a graduate degree in the Department of Industrial and Manufacturing Engineering, College of Engineering.

INDUSTRIAL ENGINEERING (I E)

- 400. ENGINEERING FOR PRODUCTION (3)
- 402. ADVANCED ENGINEERING ECONOMY (3)
- 404. MANAGEMENT SCIENCE (3)
- 405. LINEAR PROGRAMMING (3)
- 408W. HUMAN FACTORS ENGINEERING (3)
- 414. MATERIALS JOINING PROCESSES AND PRINCIPLES (3)
- 418. HUMAN/COMPUTER INTERFACE DESIGN (3)
- 419. SAFETY SYSTEMS ENGINEERING (3)
- 423. QUALITY CONTROL AND RELIABILITY (3)
- 424. PROCESS QUALITY ENGINEERING (3)
- 425. INTRODUCTION TO OPERATIONS RESEARCH (3)
- 426. INDUSTRIAL AUTOMATION (3)
- 428. METAL CASTING (3)
- 430. INDUSTRIAL PROJECT (3)
- 435. OPERATIONS RESEARCH MODELS (3)
- 438. METAL CUTTING PRINCIPLES AND PRACTICE (3)
- 445. PRODUCTION PLANNING AND CONTROL (3)
- 450. MANUFACTURING SYSTEMS ENGINEERING (3)
- 451. NUMERICAL CONTROL (3)
- 452. MICROCOMPUTERS—PROGRAMMING AND INDUSTRIAL APPLICATIONS (3)
- 453. SIMULATION MODELING OF INDUSTRIAL SYSTEMS (3)
- 454. APPLIED DECISION ANALYSIS (3)
- 455. PRODUCTION PLANNING AND CONTROL (3)
- 456. (M E) INDUSTRIAL ROBOT APPLICATIONS (3)
- 460. MATERIALS HANDLING SYSTEMS ANALYSIS AND DESIGN (3)
- 462. INTRODUCTION TO EXPERT SYSTEMS (3)
- 463. COMPUTER GRAPHICS IN INDUSTRIAL ENGINEERING (3)
- 464. ASSEMBLY OF PRINTED CIRCUIT BOARDS (3)
- 465. FACILITY LAYOUT AND LOCATION (3)
- 466. CONCURRENT ENGINEERING (3)
- 494. SENIOR THESIS (1–9)
- 496. INDEPENDENT STUDIES (1–18)
- 497. SPECIAL TOPICS (1–9)

505. LINEAR PROGRAMMING (3) An accelerated treatment of the main theorems of linear programming and duality structures plus an introduction to numerical and computational aspects of solving large-scale problems. Prerequisite: I E 405.

507. OPERATIONS RESEARCH: SCHEDULING MODELS (3) Scheduling models with simultaneous job arrival and probabilistic job arrival, network scheduling, and scheduling simulation techniques. Prerequisite: I E 425.

508. OPERATIONS RESEARCH: INVENTORY MODELS (3) The study of inventory theory, deterministic models, probabilistic models, multiproduct models for both single and multiperiod models. Prerequisite: I E 516.
509. OPERATIONS RESEARCH: WAITING LINE MODELS (3) Waiting line models including models with infinite queues, finite queues, single and multiple servers under various priorities and disciplines. Prerequisite: I E 516.
510. INTEGER PROGRAMMING (3) Study of advanced topics in mathematical programming; emphasis on large-scale systems involving integer variables. Prerequisite: I E 405.
511. EXPERIMENTAL DESIGN IN ENGINEERING (3) Statistical design and analysis of experiments in engineering; experimental models and experimental designs using the analysis of variance. Prerequisite: I E 323.
512. GRAPH THEORY AND NETWORKS IN MANAGEMENT (3) Graph and network theory; application to problems of flows in networks, transportation and assignment problems, PERT/CPM, facilities planning. Prerequisite: I E 405.
513. REAL-TIME MICROCOMPUTER APPLICATIONS (3) Study of real-time industrial engineering microcomputer applications, including the hardware and software techniques necessary to implement these systems. Prerequisites: I E 452.
514. DATA MANAGEMENT SYSTEMS DESIGN (3) Computer-based technology and design requirements for data acquisition and entry, data communications, transaction management, database management, and data utilization. Prerequisite: I E 513.
516. (MS&IS) APPLIED STOCHASTIC PROCESSES (3) Discrete and continuous time stochastic processes, including discrete time Markov chains, Poisson processes, continuous time Markov chains, and renewal processes. Prerequisite: I E 322, MS&IS 501, or STAT 318.
517. APPLIED STOCHASTIC PROCESSES II (3) Prerequisite: I E 516.
518. MATERIALS, FORMING PROCESSES, AND QUALITY (3) Study of the principles and mechanisms of conventional and developing manufacturing processes and the methods of determining work piece quality and properties. Prerequisites: I E 310, 311, or 312.
519. (MS&IS) DYNAMIC PROGRAMMING (3) Deterministic and stochastic dynamic programming. Markov decision processes. Applications to engineering and economic systems. Prerequisite: I E 516 or MS&IS 516.
520. GOAL PROGRAMMING (3) Study of concepts and methods in analysis of systems involving multiple objectives with application to engineering, economic, and environmental systems. Prerequisite: I E 405 or MS&IS 451.
521. NONLINEAR PROGRAMMING (3) Fundamental theory of optimization, including classical optimization, convex analysis, optimality conditions and duality, algorithmic solution strategies, variational methods in optimization. Prerequisite: I E 505.
522. INDUSTRIAL SYSTEMS SIMULATION (3) Study of discrete-event, network, and continuous simulation of industrial and manufacturing systems using the SLAM/GASP-IV languages; statistical techniques in simulation methodology. Prerequisites: I E 322 and FORTRAN programming ability.
528. METAL CUTTING THEORY (3) Study of the theory of metal cutting, contemporary and future problems of metal removal processes; critical analyses of current literature. Prerequisite: I E 438.
532. RELIABILITY ENGINEERING (3) Mathematical definition of concepts in reliability engineering; methods of system reliability calculation; reliability modeling, estimation, and acceptance testing procedures. Prerequisite: I E 323.
538. EXPERIMENTAL INVESTIGATIONS IN MATERIALS PROCESSING (3) Experimental investigation on selected subjects in processing involving instrumentation, methods, and analysis. Prerequisite: I E 528.
540. MANUFACTURING SYSTEMS SIMULATION (3) Use of simulation in design and process improvement of manufacturing systems. Analysis of simulation language structure. Readings in current literature. Prerequisite: I E 453.
550. MANUFACTURING SYSTEMS (3) Fundamental theory for analyzing manufacturing systems, including structural analysis, optimization and economics of manufacturing systems, automated and computer-aided manufacturing. Prerequisite: I E 450.
551. COMPUTER CONTROL OF MANUFACTURING SYSTEMS (3) Analysis of microprocessor-controlled servo loops, adaptive control, stochastic methods in control; analysis of NC machines, robots, and their controllers. Prerequisite: I E 451.
552. (BIOE, E MCH) MECHANICS OF THE MUSCULOSKELETAL SYSTEM (3) Structure and biomechanics of bone, cartilage, and skeletal muscle; dynamics and control of musculoskeletal system models. Prerequisite: consent of program. Prerequisite or concurrent: BIOL 472.

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553. (BIOE) ENGINEERING OF HUMAN WORK (3) Physics and physiology of humans at work; models of muscle strength, dynamic movements; neural control; physical work capacity; rest allocation. Prerequisite: BIOL 041 or 472.
554. PRODUCTION, PLANNING, AND CONTROL (3) Analysis of research literature for topics including scheduling, capacity planning, and lot sizing applied to manufacturing and production. Prerequisite: I E 455, 507.
556. (ME) ROBOTIC CONCEPTS (3) Analysis of robotic systems: end effectors, vision systems, sensors, stability and control, off-line programming, and simulation of robotic systems. Prerequisite: I E 456 or M E 456.
558. ENGINEERING OF COGNITIVE WORK (3) Information processing and decision making models of the human in the modern workplace, emphasizing visual inspection and other industrial applications. Prerequisites: I E 323 and 408.
560. MATERIAL HANDLING SYSTEMS (3) Modeling, analysis, and design of handling systems in manufacturing with emphasis on flow, storage, control, automation, and integration. Prerequisites: E E 405, 450.
561. WELD DESIGN (3) Weld design examining joint configuration, loading conditions, weld size, to avoid brittle fracture and fatigue failure in weldments. Prerequisite: I E 414.
562. EXPERT SYSTEMS DESIGN IN I E (3) Methodological aspects of expert systems design and review of some existing systems with emphasis on manufacturing and industrial engineering. Prerequisites: I E 450; background in one programming language would be useful.
563. COMPUTER AIDED DESIGN FOR MANUFACTURING (3) Study of CAD systems and concepts including 3D wireframe and solid modeling systems, emphasizing manufacturing applications. Prerequisite: I E 463.
565. MANUFACTURING FACILITIES DESIGN (3) Study of the factors that influence the selection and design of facilities for manufacturing. Prerequisites: I E 327, 425.
566. QUALITY CONTROL (3) Advanced quality assurance and control topics, including multivariate methods, economic design for control and acceptance, dimensioning, tolerancing, and error analysis. Prerequisite: I E 423.
571. DISTRIBUTIVE PROCESS CONTROL AND FACTORY COMMUNICATIONS (3) Analysis and design of distributive-process control architecture that incorporates data flow activity associated with sophisticated sensors, machine control, flexible communications networks, protocols and interface resolution. Prerequisite: I E 513, 514.
575. TECHNOLOGY OF MODERN MACHINE TOOL SYSTEMS (3) Mechanics and technologies useful in evaluating, monitoring, and controlling automated machine tool systems in modern manufacturing environment. Prerequisite: I E 328, 438, or 528. Prerequisite or concurrent: I E 551.
576. COMPUTER-AIDED TOLERANCING IN DESIGN AND MANUFACTURING (3) A comprehensive treatment of dimensional and geometric tolerances with computer applications for design, manufacturing, assembly, and inspection. Prerequisite: I E 450.
578. USING SIMULATION MODELS FOR DESIGN (3) Use of case study computer simulation (CAD) models for yield analysis, sensitivity analysis, performance optimization, and yield optimization. Prerequisite: I E 323.
580. ANALYSIS OF MACHINING PRECISION (3) The objective of this course is to instruct techniques for analyzing the impact of tool design and machining process parameters on workpiece geometric error. Prerequisite: I E 328.
590. I E COLLOQUIUM (1) Prerequisite: graduate standing in Industrial Engineering.
591. ACADEMIC CAREER PREPARATION SEMINAR (1) This seminar will assist Ph.D. students in preparing for careers in research and teaching. Prerequisite: completed candidacy examination.
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

INDUSTRIAL RELATIONS AND HUMAN RESOURCES (IRHR)

MARK WARDELL, *Head*
101 Old Botany Building
814-865-5425

Degree Conferred: M.S. in Industrial Relations and Human Resources

The Graduate Faculty

Michael Robert Bussel, Ph.D. (Cornell) *Assistant Professor of Labor Studies and Industrial Relations*
 Paul F. Clark, Ph.D. (Pittsburgh) *Associate Professor of Labor Studies and Industrial Relations*
 Alan Derickson, Ph.D. (California, San Francisco) *Associate Professor of Labor Studies and Industrial Relations*
 Ronald L. Filippelli, Ph.D. (Penn State) *Professor of Labor Studies and Industrial Relations*
 Gilbert J. Gall, Ph.D. (Wayne State) *Associate Professor of Labor Studies and Industrial Relations*
 Gerald P. Glyde, Ph.D. (Illinois) *Associate Professor of Labor Studies and Industrial Relations*
 Howard Harris, Ph.D. (City University of New York) *Assistant Professor of Labor Studies and Industrial Relations*
 Jackie Krasas Rogers, Ph.D. (USC) *Assistant Professor of Labor Studies and Industrial Relations*
 Elizabeth D. Scott, Ph.D. (Pennsylvania) *Assistant Professor of Labor Studies and Industrial Relations*
 James B. Stewart, Ph.D. (Notre Dame) *Professor of Labor Studies and Industrial Relations*
 Mark Wardell, Ph.D. (Missouri) *Associate Professor of Labor Studies and Industrial Relations*
 Howard Wial, J.D. (Yale) *Assistant Professor of Labor Studies and Industrial Relations*

The master of science degree in Industrial Relations and Human Resources (IRHR) is a two-year program designed for students anticipating careers in some aspect of labor and human resources or labor-management relations. The program has the following objectives: (1) provide students with an understanding of the roles employers, employees, employee organizations, and public policy makers play in the employment relationship; (2) familiarize students with the complex personal and organizational issues inherent in the employment relationship; (3) prepare students to systematically analyze complex issues and evaluate research results in the process of administering labor and human resource systems; (4) prepare students for advanced graduate or professional training beyond the master's degree; and (5) prepare students for employment as practitioners in the field.

Admission requirements

Scores from the Graduate Record Examination (GRE) or the Graduate Management Admission Test (GMAT) are required. Applicants with a 3.00 junior/senior grade-point average (on a 4.00 scale) will be considered for admission. Applicants must have three letters of recommendation sent from people who can assess adequately their likelihood of completing the graduate program.

Students are expected to have completed successfully a minimum of 12 undergraduate credits in the social sciences as part of their baccalaureate degree.

Degree Requirements

THESIS OPTION: The IRHR thesis option is intended for students anticipating additional graduate education beyond the master's degree. It requires 36 credits, including a minimum of 30 at the 400 and 500 level, and a minimum of 6 600-level thesis credits. For the degree, an overall 3.00 (B) grade-point average must be earned in the 400- and 500-level work and a grade of B or above must be earned in all 500-level courses. At least 6 credits must emphasize a particular aspect of employment relations. A student's thesis should reflect the chosen emphasis.

RESEARCH PAPER OPTION: The IRHR research paper option is intended for students expecting to enter the labor market upon completion of the master's degree. It requires a minimum of 36 credits at the 400 and 500 level. For the degree, and overall 3.00 (B) grade-point average must be earned in the 400- and 500-level work and a grade of B or above must be earned in all 500-level courses. At least 6 credits must emphasize a particular aspect of employment relations. A student's research paper should reflect the chosen emphasis.

Student Aid

Fellowships, traineeships, graduate assistantships, and other forms of financial aid are described in the STUDENT AID section of the Graduate Bulletin.

Course Requirements

CORE COURSES (21 CREDITS)

IRHR 501, 502, 504, 505, 512, 513, 516

Required course are offered once per academic year and elective courses at least once every two academic years.

INFORMATION SCIENCE

EMPHASIS COURSES (6 CREDITS)

An emphasis is an area of study related to a particular aspect or domain of industrial relations and human resources. Students select an emphasis in consultation with their master's advisory committee.

ELECTIVE COURSES (3-9 CREDITS)

With the faculty adviser's approval, a student selects at least 3 or more elective credits, depending on the chosen option. Examples of suitable elective courses are: LIR 411, 433, 444, 458W; IRHR 500, 535, 536, 594, 595, 596, 597, 599; ECON 412, 436, 571; EDADM 565, 574; HIST (LIR) 555; MGMT 321, 523, 548; PSY 441, 451, 522; SOC 455, 456, 555.

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500. TOPICS IN COMPARATIVE INDUSTRIAL RELATIONS (3 per semester, maximum of 6) Similarities and differences of various aspects in industrial relations assessed within the political, economic, and historical contexts.

501. LABOR AND EMPLOYMENT LAW (3) Legal context of employment in the United States.

502. ORGANIZATION OF THE WORKPLACE (3) Organization and transformations of the workplace and the labor process, including Taylorism, Fordism, and flexible forms.

504. SEMINAR IN INDUSTRIAL RELATIONS (3) Theory, process, and issues of the industrial relations, including collective bargaining and contract administration. Prerequisites: IRHR 512, 513.

505. SEMINAR IN HUMAN RESOURCES (3) Current human resource topics in the context of organizational strategy, planning, and responsibility. Prerequisites: IRHR 512, 513.

512. RESEARCH METHODS IN INDUSTRIAL RELATIONS AND HUMAN RESOURCES I (3) Research design, sampling design, data collection, and analysis; modeling, means and comparison of mean, correlation analysis; and case study. Prerequisites: STAT 200, 480.

513. RESEARCH METHODS IN INDUSTRIAL RELATIONS AND HUMAN RESOURCES II (3) Continuation of research design, validity and reliability; experimental design and ANOVA; survey design, and multiple regression models. Prerequisite: IRHR 512.

516. LABOR MARKET ANALYSIS (3) Neoclassical, institutional and systemic theories of external and internal labor markets and their dynamics.

535. LABOR AND HUMAN RESOURCES PUBLIC SECTOR (3) Processes and issues of employment relations in the public sector, including union-management relations and human resource issues.

536. DIVERSITY IN THE WORKPLACE (3) Women and minorities in the workplace.

594. RESEARCH TOPICS (1-18)

595. INTERNSHIP (1-18)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

599. FOREIGN STUDIES (1-12 per semester, maximum of 24)

INFORMATION SCIENCE (IN SC)

DAVID W. RUSSELL, *Division Head, Engineering*

Penn State Great Valley School of Graduate Professional Studies

30 East Swedesford Road

Malvern, PA 19355

(610) 648-3335

On the Web: www.gv.psu.edu

Degree Conferred: M.S. in Information Science

The Graduate Faculty

Robert M. Hartman, Ph.D. (Delaware) *Associate Professor of Mechanical Engineering*

Kathryn Jablokow, Ph.D. (Ohio State) *Associate Professor of Mechanical Engineering*

Eugene Kozik, Ph.D. (Pittsburgh) *Associate Professor of Industrial and Manufacturing Engineering*

John I. McCool, Ph.D. (Temple) *Associate Professor of Industrial and Manufacturing Engineering*

Effy Oz, D.B.A. (Boston) *Associate Professor of Management Science Information Systems*

Hindupur Ramakrishna, Ph.D. (Georgia State) *Associate Professor of Management Science and Information Systems*

David W. Russell, Ph.D. (London) *Professor of Electrical Engineering*
 Lily Sehayek, Ph.D. (Rutgers) *Assistant Professor of Environmental Engineering*
 Eric Stein, Ph.D. (Pennsylvania) *Associate Professor of Management Science and Information Systems*
 James Weisbecker, Ph.D. (Temple) *Assistant Professor of Computer Science*

Admission Requirements

Students who have a baccalaureate degree in data processing, information system and/or other quantitative, scientific, or business discipline will be considered for admission to the program. Students should have earned at least a 3.00/senior average in their baccalaureate program at an accredited institution. It is recommended that scores from the GRE or the GMAT be submitted. Under special circumstances, exceptions to these requirements may be considered, students with a particularly strong undergraduate background may petition to substitute advanced courses for required ones. If the admissions committee determines an area of weakness or insufficient baccalaureate preparation, the student may be required to take preparatory courses prior to being admitted to the program.

Program Requirements

The requirement for a degree are: (1) 30 credits of graduate-level course work plus a 3-credit professional paper, or (2) 39 credits of course work. The Master of Science in Information Science program is based on a sequence of: 15 credits of Required Courses; 9 credits of Core Electives; and 16 credits of General Electives. Required and elective credits must be distributed so that a minimum of 12 credits derive from the College of Business Administration and 12 credits from the College of Engineering. The remaining 6 credits may be from either program. If the students elect option one, a 3-credit professional paper in an approved topic may be completed. Alternatively, the student may elect to take an additional 9 credits in lieu of the professional paper. A grade-point average of at least 3.00 must be achieved. Variations in the distribution of credits may be allowable under special circumstances with the permission of the coordinator for the program.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

INFORMATION SCIENCE (IN SC)

- 590. COLLOQUIUM (1-3)
- 594. MASTER'S RESEARCH PAPER (1-15)
- 596. INDIVIDUAL STUDIES (1-9)
- 597. SPECIAL TOPICS (1-9)

INFORMATION SYSTEMS (INFSY)

Director of Graduate Studies

Penn State Harrisburg
 School of Business Administration
 777 W. Harrisburg Pike
 E-355 Olmsted Building
 Middletown, PA 17057-4898
 717-948-6140

Degree Conferred: M.S.

Graduate Faculty

Gregory A. Crawford, Ph.D. (Rutgers) *Senior Assistant Librarian*
 Mendi Khosrowpour, Ph.D. (Nova) *Associate Professor of Information Systems*
 Rosalie Ocker, Ph.D. (Rutgers) *Assistant Professor of Information Systems*
 Girish Subramanian, Ph.D. (Temple) *Associate Professor of Information Systems*
 Gayle Yaverbaum, Ph.D. (Temple) *Associate Professor of Information Systems*

Operating under the auspices of the School of Business Administration, Penn State Harrisburg's master's degree program in information systems is designed to meet the rapidly increasing need for technically

grounded, upperlevel information resources managers within business organizations. With the exception of a small percentage of students who are full-time, the students served by the MS/IS program are employees of area businesses, state and local governments, and not-for-profit organizations, who study on a part-time basis. In order to accommodate both full and part-time students, courses are primarily offered in the evening.

The twofold nature of the program required a manager to have competence both in information technology and in management theory; therefore, the curriculum combines the highly technical content of information science with the managerial emphasis of information systems. Unlike computer science programs, which tend to focus on computer hardware and architecture, this program is organized around applied computer-based activities, the development of communication skills, and managerial principles.

Admission Requirements

Those wishing to apply to the program must hold a baccalaureate degree in any field from an accredited, college-level institution. Decisions are based primarily on undergraduate junior-senior grade point average and the Graduate Management Admissions Test (GMAT) scores. Post-baccalaureate course work, professional experience, and the statements provided in the application are also taken into account.

Students are also required to submit: a completion application form; two copies of official transcripts from all college or universities attended; scores from the GMAT test (the test must have been taken within the past five years); application fee; letters of recommendation (optional).

The Test of English as a Foreign Language (TOEFL) must be taken by applicants for whom English is not their first language. The test must be passed with a score of 550 (written test) or higher and must have been taken within the last five years.

Please contact the Office of Enrollment Services, (717) 948-6250 or (800) 222-2056, to request an application form or with questions regarding the admissions procedure.

Entrance into the Program

Candidates may enter the program at the beginning of the fall, spring, or summer session. To allow time for applications to be processed, all information, including GMAT score, must be received by Enrollment Services no later than July 18 for admission to the fall semester, July 18 for admission to the Spring Semester, and November 18 for admission to the summer session.

Applications from outside the United States must follow the early-admission dates in order to allow the necessary clearances and paperwork to be processed in time.

Preparation for the Program

Computer Programming Requirement: Students are required to demonstrate competence through satisfactory completion of 3 credits of a high-level programming language, determined by the Information Systems faculty, completed with a grade of B or better within five years prior to admission. If this requirement has not been met, 3 credits of the designated language is required.

Mathematics Requirement: Prior to enrolling in their MS/IS course work, students are required to demonstrate competence in quantitative skills.

This may be demonstrated by: (1) satisfactory completion of a college-level calculus course such as QUANT 310 Mathematical Methods in the Social and Managerial Sciences or (2) successful completion of a mathematics proficiency examination approved by the MS/IS program. This requirement must be taken either during the first semester or summer session of the student's matriculation and completed with a grade of C or better.

Credit by Examination: Interested students should obtain a Credit By Examination form from Enrollment Services and should consult with mathematics faculty in the School of Science, Engineering, and Technology to schedule the exam and obtain a list of suggested preparatory materials.

Computer Requirement: Students are required to demonstrate competence through a college-level micro-computer applications course within the past six years (and passed with at least a B) or significant work experience. If this requirement has not been met, a college-level microcomputer course such as INFSY 305—Microcomputers in Business—is required. Course work must be taken either during the first semester or summer session of the student's matriculation and completed with a grade of B or better.

Proficiency in Writing: The MS/IS program requires the ability to think clearly and write effectively. If a score of "4" or more on the Graduate Management Admission Test (GMAT) Analytical Writing Assessment (AWA) is not achieved, then the students will need to satisfy this requirements through course work in college-level English and/or other remedial work taken either during the first semester or summer session of the student's matriculation and completed with a grade of B or better.

Business Core: Although students in the MS/IS program are not required to have prior course work in business administration, each student must complete a core of business courses. This requirement may be

satisfied by undergraduate or graduate course work completed with a grade of B or better within seven years prior to admission, or graduate work completed after admission, or college-level course work validated by recent work experience.

Graduate Business Core Courses Offered at Penn State Harrisburg:
 BUS 501. STATISTICAL ANALYSIS FOR BUSINESS DECISIONS
 ECNMS 510. MANAGERIAL ECONOMICS
 MRKT 520. MARKETING MANAGEMENT
 MNGMT 510. ORGANIZATIONAL BEHAVIOR
 MNGMT 522. OPERATIONS MANAGEMENT
 P ACC 501. FINANCIAL STATEMENT ANALYSIS

Transfer Credits and Course Waivers

Up to 10 transfer credits may be applied toward the degree. These courses must have been taken within the past five years, appear on a graduate transcript, and have been passed with a B grade or better. It must be the opinion of the reviewing faculty that these courses are equivalent in quality to those offered at Penn State Harrisburg. Credit will not be given for any class used to complete a previous degree.

Waivers are based on a minimum of 6 credits of advanced undergraduate course work in an area of concentration or credits earned in an equivalent graduate-level institution. These courses must have been completed within the past five years and have earned a grade of B or better. Waived courses must be replaced with other graduate courses. Students will be informed of this in a letter received from the program office.

Waivers are based on past academic performance. An examination cannot be used for earned course credit.

Graduation Requirements

The MS/IS program requires, excluding prerequisite requirements, 30 credits of course work at the graduate level (500-level or higher).

These are distributed over three groups of courses; Prescribed courses, Additional courses, and Electives. A minimum of 30 credits of course work, all at the graduate level, is required.

PRESCRIBED COURSES: 6 credits

INFSY 540. INFORMATION RESOURCES IN MANAGEMENT
 INFSY 554. MASTER'S PROJECT

ADDITIONAL COURSES: 18 credits from the following

INFSY 545. PROGRAM, DATA AND FILE STRUCTURES
 INFSY 550. STRATEGIC INFORMATION SYSTEMS
 INFSY 555. DATA MANAGEMENT SYSTEMS
 INFSY 560. DATA COMMUNICATIONS SYSTEMS AND NETWORKS
 INFSY 565. EXPERT SYSTEMS TECHNOLOGY MANAGEMENT
 INFSY 570. SOFTWARE ENGINEERING IN THE ANALYSIS AND DESIGN OF INFORMATION SYSTEMS
 INFSY 575. SEMINAR IN INFORMATION TECHNOLOGY MANAGEMENT
 INFSY 587. GLOBAL INFORMATION TECHNOLOGY
 INFSY 597. SPECIAL TOPICS

ELECTIVE COURSES: 6 credits

Elective courses allow students to select additional courses of interest. Six credits of elective courses must be taken from courses offered by the School of Business Administration or from graduate courses offered by other academic programs. Electives may not be part of the business core and must be selected in consultation with a faculty adviser and have MS/IS program approval.

A minimum 3.0 grade-point average is required before a student is awarded an M.S. degree in Information Systems.

All course work must be completed within six years, or seven consecutive summers of matriculation.

Financial Aid

There are a limited number of scholarships, fellowships, and research grants available, as well as several graduate assistantships. For more information on these, contact the School of Business Administration.

Many students work full-time and take classes part-time. In many cases, employers have a tuition-reimbursement plan paying for partial or full tuition.

INSTRUCTIONAL SYSTEMS

To find other options available to you, contact one of the following offices: Financial Aid—(717) 948-6307; Enrollment Services—(717) 948-6250.

INFORMATION SYSTEMS (INFSY)

540. INFORMATION RESOURCES MANAGEMENT (3) Information systems analysis, design, application, operation, and management; methods for integrating information resources into a decision support framework. Prerequisite: graduate standing. Prerequisite: graduate standing.

545. PROGRAM, DATA, AND FILE STRUCTURES (3) Program, data, and file structures are studied as they relate to management of data in information systems. Prerequisite: acceptance into MS/IS program or permission of program.

550. STRATEGIC INFORMATION SYSTEMS (3) Comprehensive coverage of concepts, applications, and management of strategic information systems in organizations. Prerequisite: INFSY 540.

554. MASTER'S PROJECT (3) Development of an original master's project in the student's field of interest and preparation of a paper. Prerequisite: last 6 credits of MS/IS program.

555. DATA MANAGEMENT SYSTEMS (3) Concepts and theory of database management systems explored through data modeling and planning techniques. Prerequisite: acceptance into MSIS program or permission of program.

560. DATA COMMUNICATIONS SYSTEMS AND NETWORKS (3) Hardware and software concepts relevant to current communications and networking technology. The importance of telecommunications is emphasized. Prerequisite: INFSY 540.

565. EXPERT SYSTEMS TECHNOLOGY MANAGEMENT (3) Expert systems and decision support with emphasis on managerial applications and the support of the decision making process. Prerequisites: graduate standing; 6 credits of programming.

570. SOFTWARE ENGINEERING IN THE ANALYSIS AND DESIGN OF INFORMATION SYSTEMS (3) Software engineering concepts, specifically the analysis and design of structured information systems using computer-aided software engineering (CASE). Prerequisite: acceptance into MS/IS program or permission of program.

575. SEMINAR IN INFORMATION TECHNOLOGY MANAGEMENT (3) Examination of selected topics relevant to current and future managerial and organizational issues of information technology. Prerequisite: INFSY 555 or 570.

587. GLOBAL INFORMATION TECHNOLOGY (3) Comprehensive coverage of components, applications, and issues of global information technology management in organizations worldwide. Prerequisite: INFSY 555 or 570.

595. INTERNSHIP (1-18)

596. INDIVIDUAL STUDIES (3)

597. SPECIAL TOPICS (1-9)

INSTRUCTIONAL SYSTEMS (INSYS)

BARBARA L. GRABOWSKI, *In Charge of Graduate Programs in Instructional Systems*
314-F Keller Building
814-865-0473

Degrees Conferred: Ph.D., D.Ed., M.S., M.Ed.

The Graduate Faculty

Alison A. Carr, Ph.D. (Indiana University) *Assistant Professor of Education*

Roy B. Clariana, Ed.D. (Memphis State) *Assistant Professor of Education*

Carol A. Dwyer, Ph.D. (Penn State) *Affiliate Associate Professor of Education*

Francis M. Dwyer, Jr., D.Ed. (Penn State) *Professor of Education*

David Alan Gallup, Ed.D. (Penn State) *Adjunct Assistant Professor of Education*

Barbara L. Grabowski, Ph.D. (Penn State) *Associate Professor of Education*

David H. Jonassen, Ed.D. (Temple) *Professor of Education*

Doris Lee, Ph.D. (Texas) *Assistant Professor of Education*

Susan M. Land, Ph.D. (Florida State) *Assistant Professor of Education*

Mary Ellen Litzinger, Ph.D. (Penn State) *Affiliate Assistant Professor of Education*

William D. Milheim, Ph.D. (Kent State) *Associate Professor of Education*

Leslie Moller, Ph.D. (Purdue) *Assistant Professor of Education*

Kyle L. Peck, Ph.D. (U of Colorado) *Associate Professor of Education*

This program provides advanced professional preparation in the development of effective, efficient instructional materials. Skill and knowledge in the fields of educational psychology, instructional design, computer technologies, development of educational materials, and evaluation of educational outcomes combine to prepare graduates for a variety of roles and professional environments. Graduates are employed by corporate, agency, and military training departments; entrepreneurial consulting companies; public school districts, community college learning resource centers, and colleges and universities. The program offers two emphasis areas for either the M.Ed. or the M.S. degrees: Training Design and Development and Interactive Learning Technologies. The M.S. and M.Ed. degrees with the corporate training emphasis are offered at Penn State Great Valley as well as University Park.

Admission Requirements

Scores from the GRE (for master's or doctorate) or Miller Analogies Test (for master's), transcripts, letters of reference, application letter, and writing assignment are required for admission. At the discretion of the program faculty, a student may be admitted provisionally for a six-month period without these scores.

Master's Degree Requirements

Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*. For the M.S. degree, EDPSY 400 (or the equivalent) is prerequisite. M.Ed. and M.S. candidates are expected to complete the following courses: INSYS 415, 521, 522, 525 or 527. The M.Ed. degree also requires a master's project paper. The M.S. degree requires INSYS 575 or EDPSY 475 and 6 credits of INSYS 600/610 plus 6 credits of professional orientation in Educational Psychology, Workforce Education and/or Adult Education. Other courses may be substituted with approval from the candidate's advisor.

Doctoral Degree Requirements

Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*. In addition to those requirements for a master's degree, D.Ed. and Ph.D. candidates are expected to complete the following courses: Ed Psych 421, two doctoral CORE courses (581, 583, or 586), 18 credits of INSTRUCTIONAL systems emphasis, three research courses covering both quantitative and qualitative methods.

As part of the candidacy exam, candidates are required to prepare residency plans indicating how they will be professionally immersed during their residency period. This plan is then reviewed again prior to graduation. The communication requirement for the Ph.D. degree may be satisfied by completing two of the following options: computer science, or statistics. Candidates for the D.Ed. degree are required to take an Internship.

Candidates for doctoral degrees with a minor in Instructional Systems must take a minimum of 15 credits approved in advance by the professor in charge of the Instructional Systems program.

Student Aid

A limited number of graduate assistantships are available to students in this program. These and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

INSTRUCTIONAL SYSTEMS (INSYS)

- 400. INTRODUCTION TO INSTRUCTIONAL TECHNOLOGY FOR EDUCATORS (1-3)
- 411. ORIENTATION TO INSTRUCTIONAL SYSTEMS (2-3)
- 412. DEVELOPING EFFECTIVE TRAINING PRESENTATIONS (3)
- 413. DESIGNING INSTRUCTIONAL MANUALS AND TEXT (3)
- 415. SYSTEMATIC INSTRUCTIONAL DEVELOPMENT (3)
- 425. CORPORATE INSTRUCTIONAL SYSTEMS (3)
- 440. AN INTRODUCTION TO COMPUTERS FOR EDUCATORS (3)
- 441. DESIGN, DEVELOPMENT, AND EVALUATION OF INTERNET RESOURCES (3)
- 442. INNOVATIVE INSTRUCTIONAL APPLICATIONS OF MICROCOMPUTER TECHNOLOGY (3)
- 443. EDUCATIONAL APPLICATIONS OF LOGO (3)
- 446. COMPUTERS AS LEARNING TOOLS (3)
- 447. INSTRUCTIONAL DESIGN FOR MULTIMEDIA TECHNOLOGIES (3)
- 448. USING THE INTERNET IN THE CLASSROOM
- 449. VIDEO AND HYPERMEDIA IN THE CLASSROOM
- 461. DESIGNING COMPUTER NETWORKS FOR EDUCATION

- 462. COORDINATING TECHNOLOGY USE IN EDUCATION
- 471. INTRODUCTION TO EDUCATIONAL SYSTEM DESIGN (3)
- 472. COMMUNICATION AND EDUCATIONAL SYSTEMS DESIGN (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497, 498. SPECIAL TOPICS (1-9)

511. ORGANIZATION AND ADMINISTRATION OF INSTRUCTIONAL SYSTEMS (3) Procedures and considerations necessary for the effective organization, management, and evaluation of instructional systems. Prerequisite: INSYS 411.

521. INSTRUCTIONAL SYSTEMS ANALYSIS (3) Conducting needs analysis, performance analysis, task analysis, learner analysis, and environmental analysis in preparation for instructional design. Prerequisites: EDPSY 421, INSYS 415.

522. ANALYZING OUTCOMES AND LEARNERS (3) Analyzing instructional outcomes, analyzing tasks, and writing objectives for the instructional design; analyzing learners characteristics. Prerequisite: INSYS 415.

525. INSTRUCTIONAL DESIGN MODELS, STRATEGIES, AND TACTICS (3) Application of instructional design models and design of appropriate instructional strategies and tactics. Prerequisite: EDPSY 421, INSYS 415.

527. DESIGNING CONSTRUCTIVIST LEARNING ENVIRONMENTS (3) Designing learning environments based on constructivist principles of learning that provide modeling, coaching, and scaffolding. Prerequisite: EDPSY 421, INSYS 415.

540. METHODS AND MODELS OF INTERACTIVE DESIGN (3) Instructional design principles and practices related to creating interactive learning environments for computerized and multimedia instruction. Prerequisite: INSYS 441.

542. EVALUATING AUTHORIZING SYSTEMS (3) Evaluation and selection of current authoring systems based on instructional design requirements. Prerequisite: INSYS 441.

543. DESIGNING INFORMATION SYSTEMS (3) The design and production of information systems that go beyond traditional instructional systems, such as performance support systems. Prerequisites: INSYS 415, 521.

544. DESIGNING VIDEO FOR INSTRUCTION AND TRAINING (3) The application of theory to the design of visual instruction for multimedia instruction. Prerequisite: INSYS 447.

545. RESEARCH IN INSTRUCTIONAL COMPUTING (3) The critical analysis of research in instructional computing and the application of research methodologies in instructional computing research. Prerequisite: INSYS 441.

547. ARTIFICIAL INTELLIGENCE IN EDUCATION AND TRAINING (3) Designing computer-based instructional and informational systems based upon principles of artificial intelligence. Prerequisites: EDPSY 421, INSYS 415.

549. CURRENT TOPICS IN EMERGING TECHNOLOGIES (3) An in-depth seminar on the instructional and training design implications of specific new technologies as they emerge. Prerequisite: INSYS 447.

551. PERFORMANCE TECHNOLOGY FOR INSTRUCTIONAL DESIGNERS (3) Methods of identifying human performance problems in organizations and developing instructional and non-instructional interventions. Prerequisite: INSYS 415.

553. MANAGING AND CONSULTING FOR INSTRUCTIONAL DEVELOPMENT (3) Knowledge and skills in managing and coordinating an instructional development project and consulting with subject matter experts and clients. Prerequisite: INSYS 525.

575. DESIGNING EXPERIMENTAL RESEARCH IN INSTRUCTIONAL SYSTEMS (3) Designing research studies in Instructional Systems of a quantitative and experimental nature. Will result in a research proposal. Prerequisite: EDPSY 475 and Ph.D. or D.Ed. candidacy.

581. THEORETICAL FOUNDATIONS OF INSTRUCTIONAL SYSTEMS (3) Analysis of the theoretical foundations of the instructional systems (systems and cybernetics, communications, cognitive psychology, sociological, constructivist, ecological) for doctoral students. Prerequisites: Ph.D. or D.Ed. candidacy.

582. COMPARATIVE INSTRUCTIONAL DESIGN MODELS (3) Analyzing different instructional design models, such as elaboration theory, component design theory, Gagne-Briggs, algorithmic, conversation theory, cognitive flexibility theory. Prerequisite: Ph.D. or Ed.D. candidacy.

583. SURVEY OF RESEARCH IN INSTRUCTIONAL SYSTEMS AND TECHNOLOGY (3) Analysis and evaluation of research in domains of instructional systems and technology. Prerequisite: Ph.D. or Ed.D. candidacy.

586. DIFFUSION AND ADOPTION OF INNOVATIONS (3) Understanding change process in educational contexts, comparing various models, tailoring them to individual needs, and creating personalized model of change. Prerequisite: admission into INSYS doctoral program.

590. COLLOQUIUM (1-3)

595. INTERNSHIP (1-18)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

INTEGRATIVE BIOSCIENCES GRADUATE PROGRAM (IBIOS)

DOROTHY SWEENEY, *Coordinator, Graduate Fellows*

Life Sciences Consortium Graduate Programs

521 Wartik Lab

(814) 863-3792

Degree Conferred: Ph. D.

The Integrative Biosciences Graduate Program is based in the Life Sciences Consortium, with faculty from the Colleges of Agricultural Sciences, Earth and Mineral Sciences, Medicine (at The Milton S. Hershey Medical Center in Hershey, Pa.), the Liberal Arts, Health and Human Development, Engineering, the Eberly College of Science, and the Sigfried and Janet Weis Center for Research in Danville, Pennsylvania.

The Integrative Biosciences Graduate Programs offers a unique opportunity to learn about and work in multiple disciplines, calling upon the expertise of individuals in different departments, different colleges, and even on different campuses, supported by modern telecommunications facilities and equipment. The doctoral program allows students not only to explore new conceptual connections, but also to engage in active group learning experiences and to explore a variety of potential career opportunities before graduation. Two unique aspects are (1) dual preceptors who will expose students to complementary viewpoints and encourage students to pursue problems at the interface between traditional disciplines, and (2) an optional internship that provides a mechanism for students to obtain “real world” experience in future professional settings.

The program offers the following options: Biomolecular Transport Dynamics; Cell and Developmental Biology; Cellular and Molecular Mechanisms of Toxicity; Chemical Biology; Ecological and Molecular Plant Physiology; Immunobiology; Molecular Medicine; Neuroscience; and Nutrition Sciences.

Program Requirements

1. Foundation of basic knowledge in molecular biology, cell biology biochemistry, and computational methods in the life sciences. The Life Sciences Consortium (LSC) expects at least 6 credits (or the equivalent) in one or more of these disciplines, taken either as an undergraduate or as a part of the graduate curriculum. The specific courses are left to the discretion of each option.
2. IBIOS 590 COLLOQUIUM (2 credits, 1 per semester during any of the first four semesters in residence), a monthly colloquium that will present life science topics of general interest to all faculty and fellows in the LSC.
3. IBIOS 591 ETHICS IN LIFE SCIENCES (1 credit), an examination of integrity and misconduct in life sciences research, including issues of data collection, publication, authorship, and peer review.
4. IBIOS 595 INTERNSHIP (optional, 1 credit), an external work assignment relevant to individual research or career goals. (Register for IBIOS 595 in 519 Wartik Lab.)
5. IBIOS 596 INDIVIDUAL STUDIES Research credits as appropriate.
6. IBIOS 597(optional) SPECIAL TOPICS
7. IBIOS 600 THESIS RESEARCH (variable credits)
8. IBIOS 601 Ph.D. DISSERTATION FULL-TIME (0 credits)
8. IBIOS 602 SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1 credit each semester), two semesters or the equivalent is required after the first year in residence. International Fellows must pass an English proficiency exam before teaching.
9. The Graduate School requires all graduate students to maintain a 3.0 grade-point average. Individual options may require a higher GPA.

Students must present their thesis in accordance with the Penn State guidelines as described in the *THESIS GUIDE Requirements for the Preparation of Master's and Doctoral Theses*. Current copies may be obtained from the Thesis Office, 115 Kern Building, University Park, PA 16802; (814) 865-5448.

General Admission Requirements

Application deadline is February 1.

1. Completed Penn State Graduate School Application
2. Paid nonrefundable \$40 application fee
3. Completed LSC Fellowship Application
4. Two official transcripts from each institution attended
5. Statement of goals that pertains to the life sciences
6. Three letters of recommendation
7. Résumé
8. Students must have completed a bachelor's degree at an accredited college or university, have a minimum of a 3.0/4.0 undergraduate grade-point average, and usually have scores over 1700 on the Graduate Record Examination test (GRE).
9. All international applicants whose first language is not English or who have not received baccalaureate or master's degrees from an institution in which the language of instruction is English must take the TOEFL (Test of English as a Foreign Language) examination. A TOEFL score of 550 on the paper test or a score of 213 on the computer-based test is required for admission to the Graduate School.

KINESIOLOGY (KINES)

KARL M. NEWELL, *Head of the Department*

146 Recreation Building

814-863-0847

Degrees Conferred: Ph.D., M.S.

The Graduate Faculty

William Buckley, Ph.D. (Penn State) *Associate Professor of Exercise and Sport Science and Health Education*

Joseph G. Cannon, Ph.D. (Michigan) *Professor of Physiology and Kinesiology*

Anthony F. Cardell, M.D. (Temple) *Adjunct Assistant Professor of Kinesiology*

Peter R. Cavanagh, Ph.D. (London, Royal Free Medical School) *Professor of Locomotion Studies*

John H. Challis, Ph.D. (Loughborough University of Technology) *Assistant Professor of Kinesiology*

Brian L. Davis, Ph.D. (Penn State) *Adjunct Assistant Professor of Exercise and Sport Science*

Craig R. Denegar, Ph.D. (Virginia) *Associate Professor of Kinesiology*

Robert B. Eckhardt, Ph.D. (Michigan) *Professor of Developmental Genetics and Evolutionary Morphology*

Peter A. Farrell, Ph.D. (Arizona) *Professor of Physiology*

James D. Gallagher, Ph.D. (Penn State) *Associate Professor of Physical Education*

Thomas J. Griffiths, Ed.D. (Maryland) *Affiliate Associate Professor of Exercise and Sport Science*

W. Larry Kenney, Ph.D. (Penn State) *Professor of Physiology and Kinesiology*

John P. Kirwan, Ph.D. (Ball State) *Assistant Professor of Physiology and Kinesiology*

Howard G. Knuttgen, Ph.D. (Ohio State) *Professor Emeritus of Applied Physiology*

R. Scott Kretchmar, Ph.D. (Southern California) *Professor of Exercise and Sport Science*

Lars G. Larsson, M.D., Ph.D. (Karolinska Institute) *Marie Noll Professor of Physiology and Neurophysiology*

Mark L. Latash, Ph.D. (Rush) *Professor of Kinesiology*

Joseph L. Loomis, M.S. (Penn State) *Senior Research Associate in Applied Physiology*

John A. Lucas, Ed.D. (Maryland) *Professor Emeritus of Exercise and Sport Science*

Herberta M. Lundegren, Ph.D. (Iowa) *Professor of Physical Education*

Shannon L. Milhalko, Ph.D. (Illinois) *Assistant Professor of Kinesiology*

Timothy P. McConnell (Kent State) *Adjunct Assistant Professor of Exercise and Sport Science*

Lorraine M. Mulfinger, Ph.D. (Penn State) *Affiliate Assistant Professor of Kinesiology*

Richard C. Nelson, Ph.D. (Michigan State) *Professor Emeritus of Biomechanics*

Karl M. Newell, Ph.D. (Illinois) *Professor of Kinesiology and Biobehavioral Health*

James A. Pawelczyk, Ph.D. (North Texas) *Assistant Professor of Physiology and Kinesiology*

George F. Salvaterra, Ph.D. (Penn State) *Affiliate Assistant Professor of Kinesiology*

Stefan K. Schaaf, Ph.D. (Technical University of Munich) *Adjunct Assistant Professor of Kinesiology*

Neil A. Sharkey, Ph.D. (California, Davis) *Associate Professor of Kinesiology*

Semyon M. Slobounov, Ph.D. (Illinois) *Assistant Professor of Kinesiology*

Ronald A. Smith, Ph.D. (Wisconsin) *Professor Emeritus of Exercise and Sport Science*
 Dagmar Sternad, Ph.D. (Connecticut) *Assistant Professor of Kinesiology*
 Karl G. Stoedefalke, Ph.D. (Illinois) *Professor Emeritus of Exercise and Sport Science*
 Kenneth L. Swalgin, Ph.D. (Ohio) *Assistant Professor of Kinesiology*
 James G. Thompson, Ph.D. (Penn State) *Professor of Exercise and Sport Science*
 Daniel L. Treviño, Ph.D. (Texas) *Associate Professor of Exercise and Sport Science*
 Nancy I. Williams, Sc.D. (Boston) *Assistant Professor of Kinesiology*
 Jerry J. Wright, Ph.D. (Ohio State) *Associate Professor of Exercise and Sport Science*
 Charles E. Yesalis III, Sc.D. (Johns Hopkins) *Professor of Health Policy and Administration, and Exercise and Sport Science*
 David Yukelson, Ph.D. (North Texas State) *Affiliate Assistant Professor of Exercise and Sport Science*
 Vladimir M. Zatsiorsky, Ph.D. (Central Institute of Physical Culture, Moscow) *Professor of Kinesiology*

The graduate programs in Kinesiology are research oriented and are designed to meet the specific goals and interests of the student. The primary goal of the overall program is to provide students the opportunity to study in depth one of the areas of specialization and to develop necessary research skills to enhance their professional competence. The master's program is designed to prepare students for future graduate study, while the doctoral program is directed toward careers in research and in teaching at the advanced undergraduate and graduate levels in colleges and universities. Areas of study (four) available at both the master's and doctoral levels are (1) biomechanics and locomotion studies, (2) exercise physiology, (3) history and philosophy of sport, and (4) motor behavior. Several well-equipped research facilities are available to support graduate study including the Biomechanics Laboratory, Motor Behavior Laboratory, Noll Physiological Research Center, and the Center for Locomotion Studies.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are required for admission. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

The minimum requirements for admission to the master's program include a 3.00 junior/senior grade-point average (on a 4.00 scale), satisfactory recommendations, a total of 1000 or higher on the verbal and quantitative sections of the GRE, and appropriate background courses in physical, biological, behavioral, and/or social science, depending on the intended area of specialization. Candidates from majors other than exercise and sport science/physical education are welcome to apply. In addition, doctoral applicants are expected to meet more stringent admission standards, including documented research capabilities (e.g., from an M.S. degree). Experience is highly desirable. Admission is highly competitive and the best qualified students will be admitted subject to space availability and compatibility of the student with the department's research mission.

Master's Degree Requirements

All master's candidates are required to complete a research methods course and an acceptable statistics course; show proficiency in the English language; and write a thesis. In addition, each specialization may require specific courses. All specializations require a minimum of 30 credits.

Doctoral Degree Requirements

A program to meet the individual needs of each student is planned with the adviser in consultation with the doctoral committee members. Students should elect at least 15 credits from courses within the Department and at least 6 credits from courses outside the Department. It is expected that the depth of knowledge in each area of study comes from independent study and research experiences, in addition to the dissertation, which are under the direction of the faculty. Specific required courses include the Colloquium and Proseminar.

Student Aid

Graduate assistantships that are available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

KINESIOLOGY (KINES)

- 400. ADAPTED PHYSICAL EDUCATION (3)
- 402. PHYSICAL ACTIVITIES FOR CHILDREN IN SPECIAL EDUCATION (3)
- 403. EMERGENCY MEDICAL TECHNOLOGY (4)
- 404. EMERGENCY MEDICAL TECHNOLOGY INSTRUCTOR (2)

409. INFLAMMATORY RESPONSES TO INJURY AND ENVIRONMENTAL STRESS (3)
420. PSYCHOSOCIAL DIMENSIONS OF PHYSICAL ACTIVITY (3)
424. (WMNST) THE FEMALE IN EXERCISE AND SPORT (3)
434. FOUNDATION OF THERAPEUTIC EXERCISE (3)
435. APPLICATION OF THERAPEUTIC EXERCISE AND REHABILITATION (2)
436. INTRODUCTION TO THERAPEUTIC MODALITIES (3)
437. APPLICATION OF THERAPEUTIC MODALITIES (2)
438. ADMINISTRATIVE ASPECTS OF ATHLETIC TRAINING (3)
- 439W. ETHICS IN SPORT AND SPORT MANAGEMENT (3)
440. (PHIL) PHILOSOPHY AND SPORT (3)
441. HISTORY OF SPORT IN AMERICAN SOCIETY (3)
442. (CAMS) SPORT IN ANTIQUITY (3)
443. MODERN OLYMPIC GAMES (3)
444. HISTORY OF ATHLETICS IN HIGHER EDUCATION (3)
445. ALCOHOL AND DRUG EDUCATION (3)
451. WORKSITE HEALTH PROMOTION (3)
456. PHYSICAL FITNESS APPRAISAL (3)
457. EXERCISE PRESCRIPTION (2)
458. EXERCISE SCIENCE CASE STUDIES (1)
463. ACQUISITION OF MOTOR SKILLS (3)
- 481W. SCIENTIFIC BASIS OF EXERCISE FOR OLDER ADULTS (3)
482. EXERCISE PROGRAMMING FOR THE OLDER ADULT (1)
483. MOTOR PATTERNS OF CHILDREN (3)
484. SPORT BIOMECHANICS (3)
485. SCIENCE OF TRAINING ATHLETES (3)
486. LEGAL ISSUES IN SPORT (3)
489. INTRAMURAL ATHLETICS (3)
- 490W. CURRICULUM DEVELOPMENT IN PHYSICAL EDUCATION (2)
491. SCHOOL ORGANIZATION AND ROLES OF HEALTH AND PHYSICAL EDUCATION TEACHERS (2)
- 492W. FITNESS PROGRAMMING FOR BUSINESSES AND AGENCIES (3)
493. PRINCIPLES, ETHICS, AND ISSUES OF ATHLETIC COACHING (3)
- 495A. PRACTICUM IN STUDENT TEACHING (13)
- 495B. FIELD AND/OR RESEARCH PRACTICUM IN KINESIOLOGY (6-12)
- 495F. FIELD PRACTICUM IN ATHLETIC TRAINING (3)
496. INDEPENDENT STUDIES (1-18)
- 497, 498. SPECIAL TOPICS (1-9)
509. (PHSIO) INFLAMMATORY RESPONSES TO INJURY AND ENVIRONMENTAL STRESS (3)
An examination of mechanisms involved in the inflammatory response and their relationship to general health, injury, and environmental adaptation. Prerequisites: B M B 251, BIOL 472, 473.
520. PSYCHOLOGY OF SPORT (3) Study of human psychological involvement and behavior in sport and physical activity; development of somatopsychic theory of physical activity. Prerequisites: 6 credits in psychology.
525. SOCIAL PSYCHOLOGY OF SPORT (3) Theory and research concerning the social-psychological basis for understanding social interaction and performance in team and individual sport settings. Prerequisite: 3 credits in social psychology.
530. EXPERIMENTAL DESIGN AND METHODOLOGY IN KINESIOLOGY (3) Research techniques, including methods, research design, techniques for data collection, as applied to relevant problems in Kinesiology. Prerequisite: 3-credit, 400-level statistics course.
535. INTERNATIONAL SPORT (3) Analysis of sport and physical education in other cultures and a comparison with the U.S.A.
562. MOTOR CONTROL: A BEHAVIORAL APPROACH (3) Analysis of theoretical and empirical basis for the psychological mechanisms underlying movement control. Prerequisite: KINES 463.
563. MOTOR LEARNING (3) Analysis of research evidence related to motor skills; characteristics of beginning and advanced performers; relevant learning principles.
565. NEUROPHYSIOLOGICAL BASIS OF MOVEMENT (3) The basic understanding of neurophysiological structures and mechanisms involved in the generation of human voluntary movement.
566. PSYCHOPHYSIOLOGY OF MOVEMENT (3) Basic concepts and principles of psychophysiology and their application for analyses of human movements.

567. (PHSIO) ADVANCED EXERCISE PHYSIOLOGY (3) Physiological changes during exercise, with emphasis on the effects of physical conditioning and training. Prerequisites: BIOL 472.
568. (PHSIO) APPLIED SKELETAL MUSCLE PHYSIOLOGY (3) An in-depth advanced understanding of the structural, morphological, and biochemical functions of muscle and changes with exercise. Prerequisites: BIOL 472, 473, KINES 480.
569. (PHSIO) LABORATORY PROCEDURES IN APPLIED PHYSIOLOGY (3) Laboratory-based study of procedures used to measure physiological and metabolic responses and adaptations to exercise, environmental, and dietary interventions. Prerequisite: BIOL 472.
576. INTERNSHIP IN ADAPTED PHYSICAL EDUCATION (3) Supervised internship in recreational, educational, or clinical situations; assessment of motor performances, evaluation of activities, and staff conference participation.
577. (PHSIO) CARDIOVASCULAR PHYSIOLOGY (3) In-depth study of the heart and circulatory system with emphasis on the effects of exercise on cardiovascular function. Prerequisites: KINES 484.
578. (PHSIO) PHYSIOLOGY AND MECHANICAL BEHAVIOR OF SKELETAL TISSUES (3). In-depth examination of the structure, composition, and material behavior of the basic skeletal tissues, including bone, cartilage, tendon, and ligament. Prerequisites: BIOL 421 and BIOL 472.
579. ADVANCED BIOMECHANICS OF HUMAN MOTION (3) Biomechanical foundation of human movement and injury prevention. Prerequisites: KINES 484; MATH 141 or 220.
580. (PHSIO) ANALYSIS OF BODY COMPOSITION (3) Study of the methods employed in the analysis of body composition. Prerequisite: BIOL 472 or 3 credits in physiology at the 400 or 500 level.
581. BIOMECHANICS (3) Kinetic and kinematic analyses of human motion utilizing electromyography and stroboscopic-photographic techniques. Prerequisites: KINES 480, 484.
582. SPORT BIOMECHANICS (3) Analysis of sports movement utilizing cinematography, electronic devices, and related research instruments.
583. SURVEY OF LOCOMOTION STUDIES (3) Mechanical/physiological factors constraining movement; solutions to overcome these constraints; muscle mechanics, locomotion studies, neural control, and gait analysis covered. Prerequisite: E MCH 011, 012, IE 553, or KINES 048.
584. ELECTROMYOGRAPHIC KINESIOLOGY (3) The theoretical background and practical application of electromyography in understanding human movement and the function of muscles. Prerequisites: KINES 480, 484.
585. (PHSIO) ENVIRONMENTAL PHYSIOLOGY (3) Human physiological response and adaptation to environmental (heat, cold, altitude) extremes. Prerequisite: 3 credits in physiology at the 400 or 500 level.
586. (PHSIO) RESEARCH METHODS IN APPLIED PHYSIOLOGY (3) Historical and current procedures for evaluation of cardiopulmonary function, metabolism, and thermal balance in humans; lecture, demonstration, and student laboratory. Prerequisite: 3 credits in physiology at the 400 or 500 level.
587. (PHSIO) APPLIED PHYSIOLOGY: AMBIENT PRESSURE (3) Physiological mechanisms activated by exposure to environmental pressure. Prerequisite: EXSCI 480 or 3 credits in physiology at the 400 or 500 level.
590. COLLOQUIUM (1)
595. (PHSIO) INTERNSHIP IN EXERCISE PHYSIOLOGY AND CARDIAC REHABILITATION (1-15) Clinical and related research aspects of exercise physiology and exercise prescription with respect to cardiac and cardiovascular rehabilitation. Prerequisites: EXSCI 456, 457, 480, PHSIO 571, 572, 590; completion of one year of graduate work.
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

LABORATORY ANIMAL MEDICINE (L A M)

C. MAX LANG, *Chair of the Department of Comparative Medicine*
 The Milton S. Hershey Medical Center
 Hershey, PA. 17033
 717-531-8460

Degree Conferred: M.S.

The department offers a postdoctoral program for veterinarians leading to the Master of Science degree with a major in Laboratory Animal Medicine. Laboratory animal medicine is a specialty of veterinary medicine that is concerned with the biology of laboratory animals and their comparative relationships to

humans. Postdoctoral training in this discipline provides a broad, basic foundation upon which the individual can build a career in teaching and research in laboratory animal medicine and/or in the professional direction of research animal facilities. The program has a strong research-oriented base with emphasis on comparative medicine and pathology.

This program is offered only at The Milton S. Hershey Medical Center. See the College of Medicine *Bulletin* for further information.

LANDSCAPE ARCHITECTURE (LARCH)

ELIZA PENNYPACKER, *Head*
210 Engineering Unit D
814-865-9511

Degree Conferred: M.L.A.

The MLA program is a post-professional degree program designed to offer students a professional undergraduate degree in landscape architecture and the opportunity to advance their academic knowledge base. The program leads to expertise in specific focus areas within the professional disciplines. The degree is the terminal degree within the discipline and is the credential necessary for teaching at a university level.

The Graduate Faculty

A. Mark Battaglia, M.L.A. (Michigan) *Professor of Landscape Architecture*
V. Vann Hala Burns, M.L.A. (North Carolina) *Associate Professor of Landscape Architecture*
Kelleann Foster, M.L.A. (Massachusetts) *Associate Professor of Landscape Architecture*
Robert Hewitt, M.L.A. (UC Berkeley) *Assistant Professor of Landscape Architecture*
Timothy P. Johnson, M.L.A. (Ohio) *Associate Professor of Landscape Architecture*
Daniel R. Jones, M.L.A. (Harvard) *Professor of Landscape Architecture*
Neil P. Korostoff, M.L.A. (Pennsylvania) *Associate Professor of Landscape Architecture*
Daniel J. Nadenicek, M.L.A. (Minnesota) *Assistant Professor of Landscape Architecture*
Eliza Pennypacker, M.L.A. (Virginia) *Professor of Landscape Architecture*
Cecelia Rusnak, M.A. (Iowa) *Assistant Professor of Landscape Architecture*
Ken Tamminga, M.P.I. (Queen's) *Assistant Professor of Landscape Architecture*
Thomas C. Yahner, M.L.A. (Penn State) *Assistant Professor of Landscape Architecture*

Admission Requirements

Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of the program, a student may be admitted provisionally for graduate study without these scores. A TOEFL score of 600 or higher is required of international applicants. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Students with a 3.00 junior/senior average (on a 4.00 scale) and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

All applicants must submit a minimum of two recommendations from faculty acquainted with the applicant's academic history; a paper of 400 to 500 words on landscape architecture stating the applicant's area of scholarly interest and expectations of graduate study, and suggesting an initial proposal for their master work thesis or project and a portfolio of creative work accomplished to date.

Applicants must have a professional undergraduate degree in landscape architecture or architecture; all applicants must submit a portfolio of designed works. Qualifying applicants may be interviewed by the Landscape Architecture Graduate Program Selection Committee.

Degree Requirements

The core curriculum is a two-year, 44-credit program: Students will be required to take studio courses at the 500 level (19 credits), a graduate seminar each of four semesters (total of 4 credits), electives (21 credits), and to develop a master work in the format of a thesis or professional or research project.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

LANDSCAPE ARCHITECTURE (LARCH)

500. REGIONAL STUDIES (1) Landscape architectural field trips within the Centre Region.

501. RESEARCH AND WRITING IN LANDSCAPE ARCHITECTURE (3) Landscape architectural research methods and writing techniques. Prerequisite: LARCH 460W and admission to the BLA/MLA program; or admission to the regular MLA program.

510. GRADUATE SEMINAR IN LANDSCAPE ARCHITECTURE (1) Landscape architectural theory exploration through readings and discussions. Prerequisite: graduate standing in the Department of Landscape Architecture.

520. GRADUATE STUDIO I (4) Landscape architectural research and design inquiry. Prerequisite: admission to the program.

530. GRADUATE STUDIO II (4) Landscape architectural research or research and design inquiry; initiation of masterwork. Prerequisite: LARCH 520.

540. GRADUATE STUDIO III (4) Landscape architectural research or research and design inquiry; development of masterwork. Prerequisite: LARCH 530.

550. GRADUATE STUDIO IV (7) Landscape architectural research or research and design inquiry; completion of masterwork. Prerequisite: LARCH 540.

560. LANDSCAPE ARCHITECTURE INQUIRY (1–9) Research, planning, and/or design inquiry into landscape architectural issues. Prerequisites: graduate standing in Landscape Architecture and approval of a member of the Landscape Architecture graduate faculty.

590. COLLOQUIUM (1–3)

597. SPECIAL TOPICS (1–9)

LANDSCAPE ARCHITECTURE, INTEGRATED UNDERGRADUATE/GRADUATE PROGRAM

ELIZA PENNYPACKER, *Professor in Charge*

210 Engineering Unit D

814-865-9511

Degrees Conferred: B.L.A./M.L.A.

The integrated BLA/MLA program is appropriate for students who already hold a baccalaureate degree and wish to receive an accredited professional undergraduate degree and nonaccredited post-professional graduate degree focused on advanced critical inquiry. Returning adult students interested in this IUG program will come from a wide array of backgrounds.

Many landscape architecture programs in the United States and Canada offer first professional M.L.A. degrees to candidates who already hold baccalaureate degrees in other fields. There are very few landscape architectural programs, however, that specialize in post-professional graduate education at the master's degree level. Our current MLA program is a major, recognized program in this specialized niche at the national level.

A BLA/MLA program provides an opportunity to tap into a wider market without initiating a first professional degree program at the graduate level. Students earn an accredited degree as undergraduates plus engage in advanced critical inquiry at the graduate level.

LANDSCAPE ARCHITECTURE (LARCH)

400. INTRODUCTION TO DESIGN AND THEORY (IUG) (9) Introductory landscape architectural design and applied theory for IUG students. Prerequisite: admission to the IUG program.

400A. INTRODUCTION TO DESIGN THEORY SEMINAR (IUG) (1) Introductory landscape architectural design theory seminar for IUG students. Prerequisite: admission to the IUG program.

425. DESIGN AND THEORY III: SITE PLANNING AND DESIGN (3)

425A. DESIGN THEORY SEMINAR (1)

427. DESIGN AND THEORY IV: SITE AND REGIONAL PLANNING (3)

427A. DESIGN THEORY SEMINAR (1)

435. LANDSCAPE ARCHITECTURAL DESIGN IMPLEMENTATION I (3)

LEISURE STUDIES

- 437. LANDSCAPE ARCHITECTURAL DESIGN IMPLEMENTATION II (3)
- 444. LANDSCAPE ARCHITECTURE FIELD TRIP I (1)
- 445. DESIGN AND THEORY V: COMMUNITY DESIGN (4)
- 445A. DESIGN THEORY SEMINAR (1)
- 451. DESIGN AND THEORY VII: URBAN DESIGN (4)
- 451A. DESIGN THEORY SEMINAR (1)
- 453. DESIGN AND THEORY VIII: ADVANCED LANDSCAPE ARCHITECTURAL DESIGN (4)
- 453A. DESIGN THEORY SEMINAR (1)
- 455. DESIGN AND THEORY IX (IUG) Integrated urban design and implementation studio for IUG students. Prerequisite: admission to the BLA/MLA program; LARCH 437, 453.
- 457. PROFESSIONAL PRACTICE (3)
- 467. LANDSCAPE ARCHITECTURE FIELD TRIP II (1)
- 472. PLANNING AND PUBLIC POLICY (3)
- 495. INTERNSHIP (1-13)
- 496. INDEPENDENT STUDIES (1-18)
- 499. FOREIGN STUDIES (1-12)
- 497. SPECIAL TOPICS (1-9)
- 499A. DESIGN THEORY SEMINAR (1)
- 499B. DESIGN AND THEORY VI: CONTEMPORARY/INTERNATIONAL LANDSCAPE ARCHITECTURAL DESIGN ISSUES (4)
- 499C. LANDSCAPE ARCHITECTURAL DESIGN IMPLEMENTATION III (3)
- 499D. CONTEMPORARY/INTERNATIONAL SPECIAL TOPICS (4)

LEISURE STUDIES (LE ST)

LINDA L. CALDWELL, *Professor in Charge*

201-G Mateer Building

814-863-8983

Degrees Conferred: Ph.D., M.S., M.Ed.

The Graduate Faculty

Linda L. Caldwell, Ph.D. (Maryland) *Associate Professor of Recreation and Park Management*

Monty L. Christiansen, M.L.A. (Iowa State) *Associate Professor of Recreation and Parks*

Diana R. Dunn, Ph.D. (Penn State) *Professor Emeritus of Leisure Studies*

Patricia Farrell, D.Ed. (Penn State) *Professor Emeritus of Leisure Studies*

Geoffrey C. Godbey, Ph.D. (Penn State) *Professor of Leisure Studies*

Alan R. Graefe, Ph.D. (Texas A&M) *Associate Professor of Leisure Studies*

Frank B. Guadagnolo, Ph.D. (Oregon State) *Associate Professor of Leisure Studies*

Deborah L. Kerstetter, Ph.D. (Penn State) *Assistant Professor of Leisure Studies*

Robert D. Lee, Ph.D. (Syracuse Univ) *Professor of Hotel, Restaurant and Institutional Management and Public Administration*

Herberta M. Lundegren, Ph.D. (Iowa) *Senior Associate Dean; Professor of Physical Education and Leisure Studies*

Stuart H. Mann, Ph.D. (Case Western Reserve) *Professor Emeritus of Operations Research*

Ralph W. Smith, Ph.D. (Penn State) *Associate Professor of Leisure Studies*

Arun Upneja, Ph.D. (U of Houston) *Assistant Professor of Hotel, Restaurant and Recreation Management*

The graduate program is designed to prepare students for administrative, supervisory, research, and teaching positions in public and private recreation and park systems, in colleges and universities, in voluntary agencies and institutions, and in commercial ventures.

The program is oriented to meet the specific needs and research interests of the candidate. Students may pursue interests in the community, including public park and recreation systems, voluntary agencies, and private commercial enterprises; tourism; institution and community-oriented therapeutic settings concerned with many different disabilities and utilizing a variety of activity modalities; park planning, resource management, interpretive services, outdoor education, and outdoor recreation services.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are required for admission to the master's and doctoral programs. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

For admission to the graduate program, a bachelor's or master's degree is required. Candidates from majors other than recreation and parks are welcome to apply; however, additional course work is required. Students with a 3.00 junior/senior average (on a 4.00 scale) and with appropriate course backgrounds will be considered for admission. All students must write a thesis.

There are no additional requirements beyond the general Graduate School requirements for the master's degree. Doctoral degree requirements include a 3.20 average for the master's degree work; understanding of a foreign culture; computer competency; and at least one year's experience in the recreation and parks field before completion of the degree.

Student Aid

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AID section of the *Graduate Bulletin*, the following award typically has been available to graduate students in this program:

U.S. OFFICE OF EDUCATION TRAINEESHIPS IN THERAPEUTIC RECREATION—Open to graduate students specializing in therapeutic recreation. Apply through the graduate program in Leisure Studies.

LEISURE STUDIES (LE ST)

510. TOURISM BEHAVIOR: AN INTERDISCIPLINARY APPROACH (3) An exploration of the various approaches that have been taken in the social sciences to understand tourism behavior. Prerequisites: 3 credits in statistics; 3 credits in behavioral science.

515. PROGRAM DEVELOPMENT AND EVALUATION (3) Critical analysis of political and societal determinants of recreation program development; research and evaluation procedures.

525. BEHAVIORAL PATTERNS OF THE OUTDOOR RECREATIONIST (3) Patterns of time and space use; user characteristics; meaning of participation; facilitation of environments-use enhancement.

527. SOCIAL PSYCHOLOGY OF LEISURE (3) Application of the methods, constructs, and theory of social psychology to the study of leisure, outdoor recreation, and therapeutic recreation.

530. RESEARCH METHODS IN LEISURE STUDIES (3) Research techniques, including methods, research design, techniques for data collection, as applied to relevant problems in the leisure studies field.

533. RECREATION STUDIES, SURVEYS AND APPRAISALS (3) Advanced procedures related to leisure, recreation, and park research. Prerequisites: LE ST 530 and 3 credits in statistics.

540. PUBLIC AND PRIVATE RECREATION LANDS AND WATERS (3) Public and private roles interactions, allocation of resources, use policies, open space concepts, private enterprise developments, legal controls.

545. PHILOSOPHICAL AND SOCIAL BASES OF LEISURE (3) Philosophical and social bases of leisure; analysis of critical issues of leisure for philosophical and social implications.

550. SEMINAR IN LEISURE STUDIES (1-6)

560. ADMINISTRATIVE PROBLEMS OF LEISURE SERVICE ORGANIZATIONS (3) Special problems of recreation and park departments; legal powers and liability; departmental organization, financing, personnel policies, and staff development.

570. CONCEPTUAL BASES FOR THERAPEUTIC RECREATION (3) Issues in the application of concepts in therapeutic recreation from a multidisciplinary perspective; evaluation and research. Prerequisite: R P M 386.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

RECREATION AND PARK MANAGEMENT (R P M)

410. MARKETING OF RECREATION SERVICES (3)

415. COMMERCIAL RECREATION MANAGEMENT (3)

420. OUTDOOR RECREATION BEHAVIOR (3)

425. PRINCIPLES OF INTERPRETIVE MATERIALS (3)

430. ENVIRONMENTAL EDUCATION METHODS AND MATERIALS (3)

433W. RESEARCH AND EVALUATION IN RECREATION AND PARKS (3)

434. RECREATIONAL FACILITY DEVELOPMENT (3)

MAN-ENVIRONMENT RELATIONS

- 435. RECREATION FACILITY PLANNING (3)
- 440. OUTDOOR EXPERIENTIAL PROGRAMMING AND ADMINISTRATION (3)
- 450. RECREATION ISSUES (1)
- 460. POLITICAL AND LEGAL ASPECTS OF RECREATION SERVICES (3)
- 462. (SOC) THE SOCIOLOGY OF LEISURE (3)
- 465. MANAGEMENT OF RECREATION SERVICES (3)
- 470. RECREATION AND PARK MANAGEMENT (3)
- 476. LEISURE EDUCATION (3)
- 477. THERAPEUTIC RECREATION SERVICE DELIVERY (3)
- 480. SENIOR MANAGEMENT SEMINAR (1)
- 486. FACILITATION TECHNIQUES IN THERAPEUTIC RECREATION (3)
- 487. ISSUES IN THERAPEUTIC RECREATION (1)
- 495A. PRACTICUM IN RECREATION AND PARKS (12)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

MAN-ENVIRONMENT RELATIONS (M E R)

WILLIAM P. ANDREW, *Professor in Charge*
201-H Mateer Building
814-863-0272

Degrees Conferred: Ph.D., D.Ed., M.S., M.Ed.

The Graduate Faculty

William P. Andrew, Ph.D. (Penn State) *Associate Professor of Hotel, Restaurant, and Institutional Finance*
Frederick J. DeMicco, Ph.D. (Virginia Polytechnic) *Associate Professor of Hotel, Restaurant, and Institutional Management*
Peter B. Everett, Ph.D. (North Carolina) *Associate Professor of Marketing*
Angela Farrar, Ph.D. (Virginia Polytechnic) *Assistant Professor of Hotel, Restaurant, and Institutional Management*
Larry D. Gamm, Ph.D. (Iowa) *Associate Professor of Health Policy and Administration*
Carolyn W. St. Pierre, Ph.D. (Tennessee) *Associate Professor of Food Systems Management*
Daniel Mount, D.B.A. (U.S. International U) *Assistant Professor of Hotel, Restaurant, and Institutional Management*
Sara C. Parks, R.D., Ph.D. (Michigan State) *Associate Professor of Dietetics*
Richard W. St. Pierre, Ph.D. (North Carolina) *Professor of Health Education*
Elwood L. Shafer, Ph.D. (SUNY, Syracuse) *Professor of Tourism*
Helen Wright, Ph.D. (Penn State) *Professor of Nutrition*

The Man-Environment Relations program offers graduate studies that focus on Hotel, Restaurant, and Institutional Management (HR&IM). This program is designed to prepare individuals for research and educational roles in the hospitality industry. (*See also* Hotel, Restaurant, and Institutional Management.)

Students in the program may elect the dual-title degree program in Operations Research for the Ph.D. and M.S. degrees. (*See also* Operations Research.)

Admission Requirements

Scores from the Graduate Record Examination (GRE), Graduate Management Aptitude Test (GMAT), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Students with a 3.00 junior/senior grade-point average (on a 4.00 scale) will be considered for admission. Exceptions to this minimum average are sometimes made for students with special backgrounds, abilities, interests, and circumstances.

An undergraduate or graduate degree in HR&IM or other equivalent hospitality-related field is required for admission to the program. In order to be admitted into the doctoral program, a master's degree (which

may be in any field if the undergraduate degree is in HR&IM or equivalent) is required. To be admitted without deficiencies into the graduate program, a student must have satisfactorily completed 3 credits each of accounting, economics, computer science, and senior or graduate-level statistics.

All students must have completed a *minimum* of two years of managerial work experience in the hospitality industry before entering the program.

Master's Degree Requirements

The master's degree program is designed to help students develop solid graduate-level research skills within a focused hospitality research area. Each student must complete a core of four courses (HR&IM 500, 503, 570, and 3 credits in International Hospitality Management). In addition, students must take a minimum of 3 credits of HR&IM 590 Colloquium. Students also complete a minimum of 15 credits of concentration area course work that is custom tailored to the student's hospitality research interests and academic and professional background.

A master's thesis is required of all students. The thesis is based on original empirical research. A master's committee of three persons who oversee the master's thesis is appointed for each candidate. This committee gives the final master's exam, which is an oral defense of the master's thesis.

Doctoral Degree Requirements

The doctoral program is an advanced graduate research program designed for students who want to become educators, researchers, and knowledge-based professionals in the hospitality field. Students' programs are individualized to ensure in addition to a mastery of the scope of knowledge in hospitality management they will also have the ability to complete significant research in a focused hospitality management area. In addition to satisfying the requirements of the Graduate School, a student must complete the following courses prior to scheduling the Ph.D. comprehensive examination: M E R 502 and 503, HR&IM 590 (1 credit each semester in residence until passing the oral comprehensive), 12 credits of quantitative and statistical analysis, 18 credits in an HR&IM concentration area, and 12 credits from an outside supporting area.

The language or communication requirement for the Ph.D. can be fulfilled by (1) demonstrating proficiency in an approved foreign language, or (2) demonstrating proficiency in computer programming, or (3) completing a minor. The demonstration of proficiency is determined by an M E R faculty committee.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

HOTEL, RESTAURANT, AND INSTITUTIONAL MANAGEMENT (HR&IM)

- 402. EQUIPMENT, LAYOUT, AND DESIGN OF HOSPITALITY OPERATIONS (3)
- 405. LEGAL ASPECTS OF HOSPITALITY SERVICE INDUSTRY (3)
- 410. ADVANCED QUANTITY FOOD PRODUCTION (2-5)
- 411. BEVERAGE MANAGEMENT AND WINE SELECTION (3)
- 412. ADVANCED INSTITUTIONAL FOOD SERVICE MANAGEMENT (4)
- 414. HOTEL FOOD AND BEVERAGE MANAGEMENT (3)
- 415. GASTRONOMY FOR RESTAURANTS (3)
- 430. ADVANCED FOOD SERVICE MANAGEMENT LABORATORY (3)
- 435. FINANCIAL MANAGEMENT IN HOSPITALITY OPERATIONS (3)
- 436. HOSPITALITY OPERATIONAL MANAGEMENT (3)
- 437. HOSPITALITY PROJECT EVALUATION AND FUNDING (3)
- 438. CASES IN FINANCIAL ANALYSIS (3)
- 442. MARKETING FOR THE HOSPITALITY INDUSTRIES (3)
- 443. SALES PLANNING AND ADVERTISING FOR HOSPITALITY OPERATIONS (3)
- 455. CONVENTION MANAGEMENT (3)
- 456. CASINO OPERATIONS MANAGEMENT (3)
- 465. ORGANIZATIONAL BEHAVIOR IN THE HOSPITALITY INDUSTRY (3)
- 466. PERSONNEL FUNCTIONS IN THE HOSPITALITY INDUSTRY (3)
- 467. MANAGEMENT OF HOTEL AND RESTAURANT EMPLOYEE RELATIONS (3)
- 470. HOSPITALITY MANAGEMENT INFORMATION SYSTEMS (3)
- 489. SEMINAR IN INSTITUTIONAL FOOD SERVICE MANAGEMENT (3)
- 490. HOSPITALITY OPERATIONS PLANNING (3)
- 491. OPERATIONAL ANALYSIS OF INSTITUTIONAL FOOD SERVICE (3)

MASS COMMUNICATIONS

493. HOSPITALITY MANAGEMENT SEMINAR (1-6)

495. HOTEL INTERNSHIP (3)

496. INDEPENDENT STUDIES (1-18)

497. SPECIAL TOPICS (1-9)

500. STRATEGIC PLANNING IN THE HRI INDUSTRY (3) The development of plans for hospitality operations, emphasizing the interrelationships of the services, financial, marketing, and human resource subsystems.

501. CURRENT ISSUES IN HRIM (3) Seminar focusing on contemporary issues impacting on the hospitality industry.

502. HRI FACILITIES PLANNING AND DESIGN (3) The planning, design, evaluation, and management of the physical plant of an HRI facility.

503. METHODS FOR HRI RESEARCH (3) an introduction to the process of research. Problem-solving approaches. The research proposal and the development of the research question.

525. INSTITUTIONAL FOOD SERVICE MANAGEMENT (3) The development of a working comprehension and integration of the institutional management into the HRI field.

535. HRI FINANCIAL ADMINISTRATION AND POLICY (3) The development of financial concepts and application relevant to HRI firm management and policy.

542. RESEARCH METHODS IN HRI MARKETING (3) Identification and use of research techniques appropriate to marketing management decision making.

550. QUANTITATIVE MODELING AND DECISION MAKING IN THE HRI INDUSTRY (3) Development and solution of mathematical models for decision making in HRI and other service industries.

565. HUMAN RESOURCE PROBLEMS IN THE HRI INDUSTRY (3) In-depth study of topics in human resource management for the HRI industry focusing on planning, organization, selection, appraisal, and legal aspects.

570. MANAGEMENT OF HRI SERVICE SYSTEMS (3) Management of domestic and international multiunit HRI service organizations.

590. (1-3 per semester, maximum of 3) COLLOQUIUM

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

MAN-ENVIRONMENT RELATIONS (M E R)

500. NONTHESIS RESEARCH (1-6)

501. PROBLEMS IN MAN-ENVIRONMENT RELATIONS (1-9) Individual directed study, investigation, and practice in selected aspects of man-environment relations.

502. SEMINAR IN MAN-ENVIRONMENT RELATIONS (1-9)

503. RESEARCH METHODS AND EVALUATION IN MAN-ENVIRONMENT RELATIONS (1-9)

MASS COMMUNICATIONS (MASSC)

RICHARD L. BARTON, *Associate Dean for Graduate Studies*

College of Communications

201 Carnegie Building

814-865-3070

Degree Conferred: Ph.D.

The Graduate Faculty

Richard L. Barton, Ph.D. (Oregon) *Associate Dean; Associate Professor of Communications;*

Robert A. Baukus, Ph.D. (Massachusetts) *Associate Professor of Communications*

R. Thomas Berner, M.A. (Penn State) *Professor of Journalism and American Studies*

Ronald Bettig, Ph.D. (Illinois) *Assistant Professor of Communication*

Barbara Bird, M.F.A. (Northwestern) *Assistant Professor of Communications*

Clay Calvert, Ph.D. (Stanford) *Assistant Professor of Communications and Law*

Jeremy Cohen, Ph.D. (Washington) *Interim Dean; Professor of Communications*

Dennis K. Davis, Ph.D. (Minnesota) *Professor of Communications*

Robert M. Frieden, J.D. (Virginia) *Professor of Communications*

Katherine T. Frith, Ed.D. (Massachusetts) *Associate Professor of Advertising*

Jeanne Hall, Ph.D. (Wisconsin) *Assistant Professor of Media Studies*

M. Heather Hartley, M.F.A. (Ohio) *Assistant Professor of Communications*
 R. Dorn Hetzel, M.F.A. (New York) *Associate Professor of Film and Video*
 Anne Hoag, Ph.D. (Michigan) *Assistant Professor of Communications*
 Chris Jordan, Ph.D. (New Mexico) *Assistant Professor of Communications*
 Ann Marie Major, Ph.D. (Southern Illinois) *Assistant Professor of Communications*
 Mary S. Mander, Ph.D. (Illinois) *Associate Professor of Communications*
 Virginia Mansfield-Richardson, Ph.D. (Ohio) *Associate Professor of Communications*
 Charles A. McMellon, Ph.D. (CUNY) *Assistant Professor of Communications*
 Eve Stryker Munson, Ph.D. (Illinois) *Assistant Professor of Communications*
 John S. Nichols, Ph.D. (Minnesota) *Associate Professor of Communications*
 Anthony A. Olorunnisola, Ph.D. (Howard) *Assistant Professor of Communications*
 Patrick R. Parsons, Ph.D. (Minnesota) *Associate Professor of Communications*
 Daniel W. Pfaff, Ph.D. (Minnesota) *Professor of Journalism*
 Robert D. Richards, J.D. (American) *Associate Professor of Communications and Law*
 Ford Risley, Ph.D. (Florida) *Assistant Professor of Communications*
 Shari Roberts, Ph.D. (Chicago) *Assistant Professor of Communications*
 Jorge Reina Schement, Ph.D. (Stanford) *Professor of Communications*
 Shyam Sundar Sethuraman, Ph.D. (Stanford) *Assistant Professor of Communications*
 E. Stratford Smith, M.L. (George Washington) *Cable TV Pioneer Chair Professor in Telecommunications Studies and Law*
 Susan M. Strohm, Ph.D. (Minnesota) *Assistant Professor of Communications*
 Richard D. Taylor, J.D. (New York) *Palmer Professor of Telecommunications Studies*
 W. Bradley Thompson, Ph.D. (Colorado) *Assistant Professor of Communications*

Doctoral Degree Requirements

The Ph.D. Program in Mass Communications is administered by the College of Communications. All students seeking admission to the program are required to submit Graduate Record Examination scores, transcripts of all previous undergraduate and graduate work, and three letters of recommendation from individuals qualified to comment on their ability to perform successfully at the doctoral level. Students whose native language is not English must present a minimum TOEFL score of 600 to be considered for admission. In most cases, a completed master's degree is required for admission to the program. In addition, applicants are required to submit a formal statement indicating what they expect to achieve and how their educational background qualifies them for doctoral-level study in mass communications. Admissions decisions are made by the admissions committee of the intercollege program in mass communications.

Requirements listed above are in addition to general Graduate School requirements listed in the GENERAL INFORMATION section of the *Graduate Bulletin*. Students admitted to the doctoral program must complete a candidacy examination. For students with a master's degree or equivalent, this examination ordinarily will occur before the student has completed 10 credits of doctoral-level work. For individuals admitted with only a baccalaureate degree and no graduate-level work, the candidacy examination will be administered after 30 credits and before 40 credits of graduate-level work, have been completed. The committee designated to conduct the examination will determine whether the student's knowledge of mass communications is adequate for doctoral-level study, specify what deficiencies, if any, must be removed, and pass judgment on a proposed plan of study.

The program requirements include both semesters of the Mass Communications Proseminar (COMM [SPCOM] 501.1 and 501.2), a foundation course and other courses selected by the student, with committee approval, that collectively constitute a coherent sequence appropriate to the advanced study of mass communications. Students are expected to take a minimum of 20 credits in communications-related courses. No more than 6 credits can be taken as independent study credits. Students also are required to take at least one course in research methods approved by the doctoral committee. Upon completion of the course work approved for the plan of study, the candidate will take a comprehensive examination. Following the comprehensive examination, doctoral candidates schedule a dissertation proposal meeting at which the research plan for their dissertation is reviewed and approved by their committee. Upon completion of the dissertation, doctoral candidates present a final oral defense of their dissertations before their committees.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by intermediate knowledge of one foreign language or by an equivalent research skill relevant to the student's field of study.

COMMUNICATIONS (COMM)

For a complete list of course descriptions, see Media Studies.

501. PROSEMINAR IN MASS COMMUNICATIONS (3) Overview of paradigms in mass communications research. Prerequisite: admission to doctoral program.

MATERIALS (MATL) — INTERCOLLEGE PROGRAM IN

ROBERT N. PANGBORN, *Chair*
117 Hammond Building
814-865-1451

ROBERT W. COLLINS, *Associate Chair (Science)*
BARBARA A. SHAW, *Associate Chair (Engineering)*
KARL E. SPEAR, *Associate Chair (Earth and Mineral Sciences)*
WILLIAM B. WHITE, *Associate Chair (Intercollege Materials Research Laboratory)*

Degrees Conferred: Ph.D., M.S.

The Graduate Faculty

Dinesh K. Agrawal, Ph.D. *Associate Professor of Materials; Senior Research Associate, Intercollege Materials Research Laboratory*
David L. Allara, Ph.D. *Professor of Materials Science and Chemistry*
Harry L. Allcock, Ph.D. *Evan Pugh Professor of Chemistry*
Maurice F. Amateau, Ph.D. *Professor of Engineering Science and Mechanics*
S. Ashok, Ph.D. *Professor of Engineering Science*
John V. Badding, Ph.D. *Assistant Professor of Chemistry*
Andrzej R. Badzian, Ph.D. *Professor of Materials; Senior Scientist, Intercollege Materials Research Laboratory*
Jayanth R. Banavar, Ph.D. *Professor of Physics*
Anthony Baratta, Ph.D. *Professor of Nuclear Engineering*
Ram B. Bhagat, Ph.D. *Associate Professor of Engineering Mechanics; Senior Research Associate*
Susan L. Brantley, Ph.D. *Professor of Solid State Science and Electrical Engineering; Senior Scientist, Materials Research Laboratory*
William R. Bitler, Ph.D. *Professor Emeritus of Metallurgy*
Paul R. Blankenhorn, Ph.D. *Professor of Wood Technology*
Andre L. Boehman, Ph.D. *Assistant Professor of Fuel Science*
Susan L. Brantley, Ph.D. *Associate Professor of Geosciences*
Paul W. Brown, Ph.D. *Professor of Ceramic Science and Engineering*
Wenwu Cao, Ph.D. *Associate Professor of Mathematics and Materials Science*
Altaf H. Carim, Ph.D. *Associate Professor of Ceramic Science and Engineering*
Gary L. Catchen, Ph.D. *Associate Professor of Nuclear Engineering*
Moses H. W. Chan, Ph.D. *Evan Pugh Professor of Physics*
Subhash Chander, Ph.D. *Professor of Mineral Processing*
Long-Qing Chen, Ph.D. *Assistant Professor of Ceramic Science*
Milton W. Cole, Ph.D. *Professor of Physics*
Lance Collins, Ph.D. *Dow Assistant Professor of Chemical Engineering*
Robert W. Collins, Ph.D. *Professor of Physics and Materials Research*
Joseph C. Conway, JR., Ph.D. *Professor of Engineering Mechanics*
L. Eric Cross, Ph.D. *Evan Pugh Professor of Electrical Engineering*
Paul H. Cutler, Ph.D. *Professor of Physics*
Makunda B. Das, *Professor Emeritus of Electrical Engineering*
Tarasankar Deb Roy, Ph.D. *Professor of Materials Science and Engineering*
Renee D. Diehl, Ph.D. *Associate Professor of Physics*
Joseph P. Dougherty, Ph.D. *Associate Professor of Materials; Senior Research Associate, Intercollege Materials Research Laboratory*
Renata S. Engel, Ph.D. *Assistant Professor of Engineering Graphics and Engineering Science and Mechanics*
Wolfgang E. Ernst, Ph.D. *Professor of Physics*

Kristen A. Fichthorn, Ph.D. *Assistant Professor of Chemical Engineering*
 Stephen J. Fonash, Ph.D. *Professor of Engineering Science; Distinguished Professor*
 Barbara J. Garrison, Ph.D. *Professor of Chemistry*
 Randall German, Ph.D. *Brush Chair, Professor of Materials*
 Eark K. Graham, Jr., Ph.D. *Professor of Geophysics*
 Thomas J. Gramila, Ph.D. *Assistant Professor of Physics*
 David J. Green, Ph.D. *Professor of Ceramic Science and Engineering*
 Michael K. Grutzeck, Ph.D. *Associate Professor of Materials*
 Ruyan Guo, Ph.D. *Associate Professor of Materials; Research Associate, Materials Research Laboratory*
 Ian R. Harrison, Ph.D. *Professor of Polymer Science*
 John R. Hellmann, Ph.D. *Assistant Professor of Ceramic Science and Engineering*
 Paul R. Howell, Ph.D. *Professor of Metallurgy*
 Thomas N. Jackson, Ph.D. *Professor of Electrical Engineering*
 Gerald G. Johnson, Ph.D. *Associate Professor of Computer Science and Engineering*
 Sridhan Komarneni, Ph.D. *Professor of Clay Mineralogy, Materials Research Laboratory*
 Donald A. Koss, Ph.D. *Professor of Materials Science and Engineering*
 Kenneth K. Kuo, Ph.D. *Distinguished Professor of Mechanical Engineering*
 Stewart K. Kurtz, Ph.D. *Murata Professor of Materials Research; Professor of Electrical Engineering*
 Peter Labosky, Ph.D. *Professor of Wood Science and Technology*
 Akhlesh Lakhtakia, Ph.D. *Associate Professor of Engineering Science and Mechanics*
 B.-L. "Les" Lee, Ph.D. *Associate Professor of Engineering Science and Mechanics*
 George A. Lesieutre, Ph.D. *Associate Professor of Aerospace Engineering*
 Qi Li, Ph.D. *Assistant Professor of Physics*
 Ying Liu, Ph.D. *Assistant Professor of Physics*
 Digby D. Macdonald, Ph.D. *Professor of Materials Science and Engineering*
 Stephen J. Mackwell, Ph.D. *Associate Professor of Geosciences*
 William D. Mark, Ph.D. *Senior Scientist, Applied Research Laboratory*
 Theresa S. Mayer, Ph.D. *Assistant Professor of Electrical Engineering*
 Julian D. Maynard, Jr., Ph.D. *Distinguished Professor of Physics*
 Merrilea Mayo, Ph.D. *Assistant Professor of Materials Science and Engineering*
 Russell F. Messier, Ph.D. *Professor of Engineering Science and Mechanics*
 Gary L. Messing, Ph.D. *Professor of Ceramic Science and Engineering*
 David L. Miller, Ph.D. *Professor of Electrical Engineering*
 Suzanne E. Mohney, Ph.D. *Assistant Professor of Materials Science and Engineering*
 Arthur M. T. Motta, Ph.D. *Assistant Professor of Nuclear Engineering*
 Karl T. Mueller, Ph.D. *Assistant Professor of Chemistry*
 Michael J. Natan, Ph.D. *Assistant Professor of Chemistry*
 Robert E. Newnham, Ph.D. *Alcoa Professor of Solid State Science*
 Timothy C. Ovaert, Ph.D. *Associate Professor of Mechanical Engineering*
 Robert N. Pangborn, Ph.D. *Professor of Engineering Mechanics*
 Carlo Pantano, Ph.D. *Professor of Materials Science and Engineering*
 Jay Patel, Ph.D. *Professor of Physics, Electrical Engineering, and Materials Research*
 Jonathan Phillips, Ph.D. *Associate Professor of Chemical Engineering*
 Howard W. Pickering, Ph.D. *Distinguished Professor of Metallurgy*
 Lawrence J. Piloni, Ph.D. *Professor of Physics*
 Richard A. Queeney, Ph.D. *Professor of Engineering Mechanics*
 Ljubisa R. Radovic, Ph.D. *Associate Professor of Fuel Science*
 Clive A. Randall, Ph.D. *Associate Professor of Materials Science and Engineering*
 Asok Ray, Ph.D. *Professor of Mechanical Engineering*
 Joseph L. Rose, Ph.D. *Paul Morrow Professor of Engineering Science and Mechanics*
 Della M. Roy, Ph.D. *Professor Emerita of Materials Science*
 Rustum Roy, Ph.D. *Evan Pugh Professor of the Solid State; Professor of Geochemistry*
 James P. Runt, Ph.D. *Professor of Polymer Science*
 Clayton O. Ruud, Ph.D. *Professor of Industrial Engineering*
 Earle Ryba, Ph.D. *Associate Professor of Metallurgy*
 Nicholas J. Salamon, Ph.D. *Professor of Engineering Science and Mechanics*
 Nitin Samarth, Ph.D. *Associate Professor of Physics*
 Robert J. Santoro, Ph.D. *Professor of Mechanical Engineering*
 Alan Scaroni, Ph.D. *Professor and Head, Department of Energy and GeoEnvironmental Engineering*

MATERIALS

Barry E. Scheetz, Ph.D. *Professor of Materials, Civil and Environmental Engineering, and Nuclear Engineering*
Darrell G. Schlom, Ph.D. *Associate Professor of Materials Science and Engineering*
Harold Schobert, Ph.D. *Associate Professor of Fuel Science*
Barbara Shaw, Ph.D. *Associate Professor of Engineering Science and Mechanics*
Thomas R. Shrout, Ph.D. *Professor of Materials*
Michael R. Silsbee, Ph.D. *Associate Professor of Materials*
George Simkovich, Ph.D. *Professor Emeritus of Materials Science*
Jogender Singh, Ph.D. *Assistant Professor of Materials Science and Engineering*
Deane K. Smith, Ph.D. *Professor Emeritus of Mineralogy*
Paul Sokol, Ph.D. *Professor of Physics*
Karl E. Spear, Ph.D. *Professor of Ceramic Science*
Peter Thrower, Ph.D. *Professor of Materials Science*
Bernhard R. Tittmann, Ph.D. *Schell Professor of Engineering Science and Mechanics*
Richard E. Tressler, Ph.D. *Professor of Materials Science and Engineering*
Susan Troiler-McKinstry, Ph.D. *Associate Professor of Ceramic Science and Engineering*
Kenji Uchino, Ph.D. *Professor of Electrical and Computer Engineering*
M. Urquidi-Macdonald, Ph.D. *Associate Professor of Engineering Science and Mechanics*
Vasundara V. Varadan, Ph.D. *Alumni Distinguished Professor of Engineering*
Vijay Varadan, Ph.D. *Alumni Distinguished Professor of Engineering*
Robert C. Voight, Ph.D. *Professor of Industrial Engineering*
William B. White, Ph.D. *Professor of Geochemistry*
Roy F. Willis, Ph.D. *Professor of Physics*
Nicholas Winograd, Ph.D. *Evan Pugh Professor of Chemistry*
Christopher R. Wronski, Ph.D. *Leonhard Professor of Electrical Engineering*
Xiaoxing Xi, Ph.D. *Assistant Professor of Physics*
Walter Yarbrough, Ph.D. *Assistant Professor of Ceramic Science and Engineering*
Qiming Zhang, Ph.D. *Associate Professor of Materials and Electrical Engineering*
Xiang Zhang, Ph.D. *Associate Professor of Industrial Engineering*
Gregory R. Ziegler, Ph.D. *Associate Professor of Food Science*

The aim of the intercollege program in Materials is to provide an opportunity for the student interested in the structure, properties, and behavior of solid materials to obtain an integrated program of courses encompassing both the necessary fundamentals of chemistry, physics, and mathematics and their technological and engineering applications.

The program is designed to encourage graduate study and research that cut across the traditional engineering disciplines and scientific inquiry related to materials. Faculty members associated with the program come from several colleges and many research centers at the University.

In order to maintain focus for the selection of core courses and for the administration of the comprehensive examination, formal options have been established (i.e., Materials Science and Materials Engineering). These options differ in the specification of core courses and in the focus of the research. Other program requirements are common for the two options.

Admission Requirements

Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are recommended but not required for admission. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Entering students should hold a bachelor's degree in chemistry, physics, mathematics, geological science, engineering, ceramics, or metallurgy, or in a closely related field that will have included in it mathematics at least through integral calculus and a minimum of one year of physics and one year of chemistry. Students with a 3.00 junior/senior grade-point average (on a 4.00 scale) and with appropriate course backgrounds will be considered for admission. Exceptions to the 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests. The applicant should be interested specifically in an interdisciplinary program of study and research.

Master's Degree Requirements

The program for the M.S. degree must include a total of 30 credits as outlined in the GENERAL INFORMATION section of the *Graduate Bulletin*. The candidate must prepare a thesis proposal and list of courses for approval by the program faculty constituting the student's M.S. committee. A thesis

describing original work performed by the student shall be written and defended before the M.S. committee.

Doctoral Degree Requirements

Acceptance into the Ph.D. program is based on the student's performance on the Ph.D. candidacy exam administered by a rotating committee of program faculty. The examination is designed to evaluate the student's potential for original and successful Ph.D. research and is composed of a written proposal and oral presentation. Detailed plans for thesis research and course work consistent with the student's declared option are to be presented to the Ph.D. committee following successful completion of the candidacy exam, and the student is to present periodic progress reports to the committee until the thesis is defended. Near the end of the period of formal course work, each student will take a comprehensive exam. The examination consists of a written part administered by a rotating committee of program faculty, based on specific areas of knowledge depending on the chosen option, and an oral part, administered by the candidate's Ph.D. committee, that will emphasize an understanding of both fundamentals and the student's area of specialization. At the culmination of the Ph.D. research experience, each candidate must write a thesis, present it to his/her Ph.D. committee, and defend it at a public, oral presentation, followed by an examination by the committee. All candidates must demonstrate proficiency in English in both written and oral form, which is established formally in conjunction with the candidacy exam.

Other Relevant Information

Seminar series are offered on various materials topics under the course listing MATL 590 Colloquium, and students are encouraged to enroll in these courses or to take materials-related seminar courses offered by other departments. The program offers instruction on special topics under the designation MATL 597, or students may explore such areas individually under a faculty member's supervision, receiving credit under the designation MATL 596.

Thesis research on various aspects of the solid state may be conducted in the Intercollege Materials Research Laboratory, Applied Research Laboratory, or appropriate departments in the Colleges of Earth and Mineral Sciences, Engineering, or Science. A wide variety of experimental facilities for materials research are available.

Student Aid

Assistance is provided by the program office in identifying and applying for fellowships and scholarships from internal and external sources, and in facilitating linkages with faculty and units that can offer support in the form of graduate assistantships for research in specific topical areas. These and other types of financial aid are described in the STUDENT AID section of the *Graduate Bulletin*.

MATERIALS SCIENCE AND ENGINEERING (MATSE)

RICHARD E. TRESSLER, *Head of the Department of Materials Science and Engineering*
101 Steidle Building
814-865-0497

JOHN R. HELLMANN, *In Charge of the Ceramic Science Option*
201 Steidle Building
814-863-2011

ALAN W. SCARONI, *In Charge of the Fuel Science Option*
209 Academic Projects Building
814-865-6511

KWADWO OSSEO-ASARE, *In Charge of the Metals Science and Engineering Option*
208 Steidle Building
814-865-5446

PAUL C. PAINTER, *In Charge of the Polymer Science Option*
319 Steidle Building
814-865-1288

Degrees Conferred: Ph.D., M.S.

The graduate program in materials science and engineering offers comprehensive graduate education in the fundamentals of materials science (synthesis-structure-property performance relationships) applied to the major classes of materials, including ceramics, glass, metals, polymers, composites, electronic and photonic materials, and fuel materials. In this regard the student elects to specialize in one of the four options in the Materials Science and Engineering program. The options are ceramic science, fuel science, metals science and engineering, and polymer science. Each option has specific faculty associated with it and a professor in charge of administering the option. The graduate program has overall requirements for the M.S. and Ph.D. degrees with specific requirements associated with each option.

Students who prefer a general materials science degree may choose to enroll in the Intercollege Graduate Program in Materials (MATL) and select the materials science option within that major. The Department of Materials Science and Engineering is strongly represented by the involvement of its faculty in that materials science option.

Admission Requirements

Scores for the Graduate Record Examination (GRE) are required for admission, though this may be waived at the discretion of the options. The best-qualified applicants will be accepted up to the number of spaces available for new students. Students will be referred to the option to which their interests are most closely allied. The degree requirements listed here are in addition to the general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Master's Degree Requirements

The program for the M.S. degree must include a total of at least 30 credits as outlined in the GENERAL INFORMATION section of the *Graduate Bulletin*. The candidate must write a thesis on independent research and defend the thesis. The thesis will be based on at least 6 credits of thesis research in the option and it must conform to Graduate School standards. Each option requires 21 credits of formal course work, but the type and level of these courses are specified by the options.

Doctoral Degree Requirements

Acceptance into the Ph.D. degree program is based on the student's performance on the Ph.D. candidacy exam administered by the faculty of the option. The candidacy exam is based on a written examination on prior course work and an oral examination on knowledge of the field, or defense of a research proposal or M.S. thesis, **depending on the option**. On completion of course work, each option administers a comprehensive exam in the area of specialization and this involves both written and oral examinations. Each option has provisions for periodic progress reports to the Ph.D. thesis committee by the candidate. At the culmination of the Ph.D. thesis research experience, each candidate must write a thesis, present it to his/her Ph.D. committee, and defend it at a final oral exam. All candidates must demonstrate proficiency in English in both written and oral form and this is tested formally during the candidacy examination.

Other Relevant Information

All graduate students are expected to attend general department seminars and seminars in their option. They may receive credit for these seminar courses by registering for the seminar course in the option of the MATSC 590 course.

Graduate students may be asked to contribute to the instructional program of the department by assisting with laboratory and lecture courses. If so, the student should register for MATSC 602 Supervised Experience in College Teaching.

Student Aid

Several fellowships are available through the department in the various options. Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

MATERIALS SCIENCE AND ENGINEERING (MATSE)

- 400. CRYSTAL CHEMISTRY (3)
- 401. THERMODYNAMICS OF MATERIALS (3)
- 402. MATERIALS PROCESS KINETICS (3)
- 410. PHASE RELATIONS IN MATERIALS SYSTEMS (3)
- 413. SOLID STATE MATERIALS (3)
- 416. MATERIALS PREPARATION (2)
- 430. MATERIALS CHARACTERIZATION (3)

- 435. OPTICAL PROPERTIES OF MATERIALS (3)
- 440. (E MCH) SURVEY OF QUANTITATIVE NONDESTRUCTIVE EVALUATION (3)
- 450. (E SC) SYNTHESIS AND PROCESSING OF EPM (3)
- 455. PROPERTIES AND CHARACTERIZATION OF EPM (3)
- 461. INTRODUCTION TO EPM LABORATORY (1)
- 463. CHARACTERIZATION AND PROCESSING OF EPM LABORATORY (1)
- 475. (E SC) PARTICULATE MATERIALS PROCESSING (3)
- 493W. SENIOR RESEARCH PROJECT I (1)
- 494W. SENIOR RESEARCH PROJECT II (1)
- 496. INDEPENDENT STUDIES (1–18)
- 497. SPECIAL TOPICS (1–9)

MATERIALS SCIENCE (MATSC)

- 501. THERMODYNAMICS OF MATERIALS (3) Application of thermodynamics to material equilibria and processes, including solution theory, electrochemical processes, capillarity, and the effect of stresses. Prerequisite: CHEM 451.
- 503. (GEOSC) KINETICS OF MATERIALS PROCESSES (3) Introduction to application of transition state theory and mass transfer to the kinetics of materials and mineral processes. Prerequisites: MATH 520, CHEM 451; MATSE 501 or GEOSC 519.
- 509. COMPOSITE MATERIALS (3) Manufacturing processes, atomic and molecular background, and topological relationships of macro-microstructure to the physical properties of composites.
- 511. (GEOSC) INSTRUMENTAL TECHNIQUES APPLIED TO MATERIALS AND MINERAL SCIENCES PROBLEMS (1–7) See units A through G for description.
 - Unit A. (GEOSC) POWDER X-RAY DIFFRACTION (1) Compound identification, lattice parameter measurement, and other applications of the powder diffraction method.
 - Unit B. (GEOSC) TRANSMISSION ELECTRON MICROSCOPY (1) Principles and practice of transmission electron microscope operation. Students undertake individual projects.
 - Unit C. (GEOSC) SPECTROSCOPY (1) Emission spectrographic analysis of powders and atomic absorption analysis of solutions.
 - Unit D. (GEOSC) ELECTRON MICROPROBE ANALYSIS (1) Qualitative and quantitative elemental analysis of microvolumes within solids. Emphasis on individual student project.
 - Unit E. (GEOSC) SCANNING ELECTRON MICROSCOPY (1) Principles and practice of scanning electron microscope operation. Students undertake individual projects.
 - Unit G. (GEOSC) ANALYTICAL ELECTRON MICROSCOPY (1) Modern analytical electron microscope techniques: scanning transmission electron microscopy; electron energy loss spectroscopy; energy dispersive analysis of X-rays. Prerequisite: MATSE (GEOSC) 511B.
- 512. (GEOSC) PRINCIPLES OF CRYSTAL CHEMISTRY (3) Relation of structure to ionic size and nature; influence of pressure and temperature on structure; chemical–structural defects, crystalline solutions, phase-transitions.
- 514. CHARACTERIZATION OF MATERIALS (3) Classical and new (microprobe, scanning microscope, magnetic resonance, and Mossbauer) techniques for the characterization of composition, structure, defects, and surfaces.
- 524. (GEOSC) VIBRATIONAL SPECTRA OF MATERIALS AND MINERALS (3) Infrared and Raman spectroscopy of materials, with applications to mineralogy, geochemistry, ceramics, and glass research.
- 530. X-RAY CRYSTALLOGRAPHY AND DIFFRACTION (3) Reciprocal lattices and the Ewald sphere construction; crystal structure determination by powder and single crystal techniques; space groups. Prerequisite: MATSE 430.
- 531. TRANSMISSION ELECTRON MICROSCOPY (3) Diffraction pattern analysis and simple contrast theory applied to the structures of materials; analytical techniques in the microscope. Prerequisite: MATSE (GEOSC) 411B.
- 535. (GEOSC) GEOMETRICAL CRYSTALLOGRAPHY (3) Derivation of lattices, types, point groups, and space groups; and group theory applied to crystallography and spectroscopy.
- 536. TECHNIQUES FOR SURFACE ANALYSIS (3) Electron spectroscopy, low-energy ion-beam techniques, high-energy ion-beam techniques, low-energy electron diffraction, and ellipsometry. Prerequisite: PHYS 203 or 204.
- 540. CRYSTAL ANISOTROPY (3) Symmetry aspects of crystals and physical properties. Matrix and tensor methods. Prerequisite: PHYS 412.
- 542. MAGNETIC METHODS IN MATERIALS SCIENCE (3) Static magnetic (susceptibility type) and spectroscopic methods (nuclear and electron magnetic resonance, Mossbauer spectroscopy) for materials characterization and structural analysis. Prerequisite: PHYS 413.

554. ELECTRONIC SPECTRA OF MATERIALS (3) Crystallographic and thermodynamic applications of crystal field theory. Electronic spectra of crystals and glasses. Luminescent spectra and phosphor characterization. Prerequisite: PHYS 471.

570. CATALYTIC MATERIALS (3) Preparation and characterization of solid catalytic materials. Relationships between their surface, defect, and electronic properties and catalytic activity. Prerequisite: CHEM 452.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

CERAMIC SCIENCE OPTION

The Graduate Faculty

James H. Adair, Ph.D. (Florida) *Associate Professor of Materials Science and Engineering*

Paul W. Brown, Ph.D. (Wisconsin) *Professor of Ceramic Science and Engineering*

Altat H. Carim, Ph.D. (Stanford) *Associate Professor of Materials Science and Engineering*

Long-Qing Chen, Ph.D. (MIT) *Associate Professor of Ceramic Science and Engineering*

David J. Green, Ph.D. (McMaster) *Professor of Ceramic Science and Engineering*

John R. Hellmann, Ph.D. (Penn State) *Associate Professor of Ceramic Science and Engineering*

Gary L. Messing, Ph.D. (Florida) *Professor of Ceramic Science and Engineering*

Robert. E. Newnham, Ph.D. (Penn State, Cambridge) *Professor Emeritus of Solid State Science*

Carlo G. Pantano, Ph.D. (Florida) *Professor of Materials Science and Engineering*

Clive A. Randall, Ph.D. (Essex) *Associate Professor of Materials Science and Engineering*

Guy Rindone, Ph.D. (Penn State) *Professor Emeritus of Ceramic Science and Engineering*

Darrell Schlom, Ph.D. (Stanford) *Associate Professor of Materials Science and Engineering*

Karl E. Spear, Ph.D., (Kansas) *Professor of Materials Science and Engineering*

Vladimir S. Stubican, Dr.Phil. (Zagreb), D.Sc. *Professor Emeritus of Materials Science and Engineering*

Richard E. Tressler, Ph.D., (Penn State) *Head and Professor of Materials Science and Engineering*

Susan Trolrier-McKinstry, Ph.D. (Penn State) *Associate Professor of Ceramic Science and Engineering*

William O. Williamson, D.Sc. (London), *Professor Emeritus of Ceramic Science and Engineering*

Walter A. Yarbrough, Ph.D. (Penn State) *Assistant Professor of Ceramic Science and Engineering*

In addition to these faculty members, other Materials Science, Electrical Engineering, Engineering Science and Mechanics, and Geosciences faculty members advise or co-advise Ceramic Science graduate students.

This program is one of the advanced degree options in the Department of Materials Science and Engineering. In view of the wide field covered by ceramic science, the graduate course may be selected with special emphasis in ceramic processing, physical ceramics, chemical ceramics, or glass science.

Special facilities exist for research in the areas of electroceramics, ceramic processing, phase equilibria, solid state synthesis, mechanical properties, ferrite and ferroelectric studies, glass science, surface characterization and properties, high temperature reaction kinetics and corrosion studies. Suitable preparation for graduate study in this program may be found in one of the material sciences, such as ceramics or metallurgy, in engineering fields such as chemical or mechanical engineering, in the basic physical sciences, or in the earth sciences.

CERAMIC SCIENCE AND ENGINEERING (CERSE)

404. CERAMIC SEMINAR AND FIELD TRIP (1)

406. PROCESSING OF CERAMICS (3)

408. THERMAL PROPERTIES AND REFRACTORIES (3)

411. SOLID STATE REACTIONS IN CERAMICS (3)

414. MECHANICAL PROPERTIES OF CERAMICS (3)

415. INTRODUCTION TO GLASS SCIENCE (3)

430. ELECTRICAL AND MAGNETIC PROPERTIES (3)

461. CERAMICS LABORATORY I (0.5)

462. CERAMICS LABORATORY II (0.5)

463. CERAMICS LABORATORY III (1)

464. CERAMICS LABORATORY IV (1)

493W. SENIOR THESIS RESEARCH (1)

- 494W. SENIOR THESIS (2)
 496W. SENIOR THESIS (1–18)
 497. SPECIAL TOPICS (1–9)

CERAMIC SCIENCE (CERSC)

502. MECHANICAL PROPERTIES OF CERAMICS I (3) Theoretical considerations of crystallographic and microstructural aspects of the elastic and fracture characteristics of ceramics.
 Prerequisite: CERSE 414 or E MCH 415.
 504. SOLID STATE REACTIONS IN CERAMIC SYSTEMS (2) Thermodynamic, kinetic, and structural study of reactions and of equilibrium in ceramic systems. Prerequisite: CHEM 451, 452.
 507. THERMAL PROPERTIES OF CERAMICS (2–3) Heat capacity, heat of fusion, thermal conductivity, and thermal expansion in relation to macroscopic measurements and basic atomic concepts applied to ceramic materials.
 508. DIELECTRIC AND MAGNETIC PROPERTIES OF CERAMIC MATERIALS (2–3) Preparation and properties of ceramic semiconductors, dielectrics, and magnetic materials.
 510. SEMINAR IN GLASS TECHNOLOGY (1–2 per semester) Current developments in glass technology and related fields.
 512. CHEMICAL ROUTES TO CERAMICS (3) Formation of ceramics by reaction bonding, sol-gel processing, hydrothermal synthesis, controlled oxidation processes, biological mineralization; relevant multicomponent phase equilibria and interfacial phenomena.
 513. SINTERING OF CERAMICS (3) Design and interpretation of ceramic microstructures through an understanding of the physics and chemistry of sintering and grain growth. Prerequisite: CERSE 406.
 590. COLLOQUIUM (1–3) Continuing seminars that consist of individual lectures by faculty, students, or outside speakers.
 596. INDIVIDUAL STUDIES (1–9)
 597. SPECIAL TOPICS (1–9)

FUEL SCIENCE OPTION

(This option is scheduled to become a degree program in the Department of Mineral Engineering in fall 1999.)

The Graduate Faculty

- André L. Bochman, Ph.D. (Stanford) *Assistant Professor of Fuel Science*
 Semih Eser, Ph.D. (Penn State) *Associate Professor of Fuel Science*
 Howard B. Palmer, Ph.D. (Wisconsin) *Professor Emeritus of Energy Science*
 Sarma Pisupati, Ph.D. (Penn State) *Assistant Professor of Fuel Science*
 Ljubisa R. Radovic, Ph.D. (Penn State) *Professor of Fuel Science*
 Alan W. Scaroni, Ph.D. (Penn State) *Professor of Fuel Science*
 Harold H. Schobert, Ph.D. (Iowa State) *Professor of Fuel Science*
 Chunshan Song, Ph.D. (Osaka) *Associate Professor of Fuel Science*
 Peter A. Thrower, Ph.D. (Cambridge) *Professor Emeritus of Materials Science*
 Francis J. Vastola, Ph.D. (Penn State) *Professor Emeritus of Fuel Science*
 Philip L. Walker, Jr., Ph.D. (Penn State) *Evan Pugh Professor Emeritus of Materials Science*

The graduate programs in Fuel Science provide instruction and research opportunities to acquire advanced professional knowledge in the characteristics and utilization of fuels, including their conversion to energy, to other fuels, or to other materials, and environmental protection through pollution prevention and abatement.

Well-equipped research facilities are available for investigation of the chemical and physical characteristics of fuels, petroleum and natural gas processing and conversion, catalysis, fundamentals of gasification, liquefaction, and coprocessing of fuels, organic geochemistry of plant-derived sediments, physics and chemistry and physics of combustion phenomena, and pollutant formation and control. Students can plan a wide variety of programs of study to suit individual needs; coherent interdisciplinary programs are encouraged.

FUEL SCIENCE (F SC)

401. INTRODUCTION TO FUEL TECHNOLOGY (3)
 410. FUEL SCIENCE LABORATORY (1–3)
 421. COMBUSTION SCIENCE (3)

MATERIALS SCIENCE AND ENGINEERING

- 422. COMBUSTION ENGINEERING (3)
- 430. AIR POLLUTANTS FROM COMBUSTION SOURCES (3)
- 431. THE CHEMISTRY OF FUELS (3)
- 432. PETROLEUM PROCESSING (3)
- 435. INDUSTRIAL ORGANIC CHEMISTRY (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

- 503. PROBLEMS IN FUEL SCIENCE (5) A problem-based, active learning course on the fundamental principles of fuel science applied to fuel processing, combustion, and conversion. Prerequisites: F SC 421, 422, 431.
- 504. PROBLEMS IN FUELS ENGINEERING (5) A problem-based, active learning course on the application of the principles of fuels engineering to the efficient and environmentally acceptable use of coal, petroleum, and natural gas. Prerequisites: F SC 421, 422, 431.
- 506. CARBON REACTIONS (3) Current approaches to heterogeneous reactions in combustion and gasification of carbonaceous solids, including those derived from coal and petroleum sources. Prerequisite: CHEM 452.
- 590. COLLOQUIUM (1-3)
- 596. INDIVIDUAL STUDIES (1-9)
- 597. SPECIAL TOPICS (1-9)
- 597A. FIELD TRIP (1)

METALS SCIENCE AND ENGINEERING OPTION

The Graduate Faculty

- William R. Bitler, Ph.D. (Carnegie Tech.) *Professor Emeritus of Metallurgy*
- Tarasankar DebRoy, Ph.D. (Inst. of Science, Bangalore) *Professor of Materials Science and Engineering*
- Paul R. Howell, Ph.D. (Cambridge) *Professor of Metallurgy*
- Digby D. Macdonald, Ph.D. (Calgary) *Professor of Materials Science*
- Merrilea J. Mayo, Ph.D. (Stanford) *Associate Professor of Materials Science*
- Suzanne E. Mohny, Ph.D. (Wisconsin) *Assistant Professor of Metallurgy*
- Kwadwo Osseo-Asare, Ph.D. (California) *Professor of Metallurgy*
- Howard W. Pickering, Ph.D. (Ohio State) *Distinguished Professor of Metallurgy*
- Earle R. Ryba, Ph.D. (Iowa State) *Associate Professor of Metallurgy*
- George Simkovich, Ph.D. (Penn State) *Professor Emeritus of Materials Science*

This program is one of the advanced degree options in the Department of Materials Science and Engineering.

METALS SCIENCE AND ENGINEERING (METAL)

- 400. CORROSION FORMS AND PREVENTION (3)
- 402. CORROSION ENGINEERING (2)
- 404. THERMOCHEMICAL PROCESSING (3)
- 405. PHASE TRANSFORMATIONS IN METALS AND ALLOYS (3)
- 406. DEFORMATION, FRACTURE, AND ALLOY DESIGN (3)
- 408. PROCESSING OF METALS (3)
- 410. METALLURGICAL INVESTIGATIONS AND DESIGN (1-6)
- 416. HYDROMETALLURGY LABORATORY (1)
- 426. (MN PR) AQUEOUS PROCESSING (3)
- 432. FERROUS PHYSICAL METALLURGY (3)
- 434. METALLURGY LABORATORY I (1)
- 435. METALLURGY LABORATORY II (1)
- 436. METALLURGY LABORATORY III (1)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
- 501. METALLURGICAL PROBLEMS (1-6 per semester) Independent study of special problems in metallurgy.
- 505. OXIDATION OF METALS (3) The course will cover high-temperature oxidation of metals and alloys including Wagner's theories of internal oxidation. Prerequisite: CHEM 451.

507. (MN PR) HYDROMETALLURGICAL PROCESSING (3) Fundamental physicochemical factors underlying the aqueous extraction and recovery of metals and nonmetals from ores, minerals, and scrap metal. Prerequisite: METAL (MN PR) 426.
508. KINETICS OF PHASE TRANSFORMATIONS (3) Application of statistical mechanics and absolute rate theory to kinetics of phase transformations, including diffusion, nucleation, and growth rates.
509. INTRODUCTORY THEORETICAL PHYSICAL METALLURGY (3) Quantum mechanics and its application to solid-state theory; introduction of Schrodinger's equation, its solutions, free-electron model, band model.
510. MAGNETIC AND TRANSPORT PROPERTIES OF MATERIALS (3) Treatment of the magnetic and transport properties of solids by quantum mechanics with applications to practical alloy development. Prerequisite: METAL 509.
513. ADVANCED CHEMICAL METALLURGY I (3) Application of thermodynamics and kinetics to the heterogeneous metallurgical processes of oxidation, reduction, smelting, and refining. Prerequisite: METAL 404.
514. DISLOCATION THEORY (3) Self- and interaction energies of dislocations and other defect structures; dislocation motions and their relation to mechanical properties.
515. CORROSION OF METALS (3) Phenomena and theories of metallic corrosion; principles of alloy selection for engineering and structural uses in corrosive environments.
517. METAL ELECTRODE REACTIONS (2-3) Evaluation of electrode reaction mechanisms at metal/water and metal/oxide/water interfaces relevant to corrosion and industrial electrolyte processes. Prerequisites: CHEM 451.
519. ADVANCED CHEMICAL METALLURGY II (3) Application of thermodynamics and kinetics to precipitation of nonmetallic and metallic phases from liquid and solid metals at elevated temperatures. Prerequisite: METAL 513.
522. SOLID-PHASE REACTIONS IN METALS (3) Mechanisms and rate-determining factors in solid-phase reaction in metals; diffusion processes, nucleation theory, precipitations from solid solution, eutectoid decomposition and order-disorder phenomena. Prerequisite: METAL 508.
534. (E MCH) MICROMECHANISMS OF FRACTURE (3) Mechanisms of fracture and their relationship to loading conditions, environment, flow behavior, processing history, and microstructure. Prerequisites: E SC 414H, METAL 406.
535. (E MCH) CRYSTAL DEFECTS AND DEFORMATION (3) Deformation of crystalline solids containing defects; elastic and plastic responses over a range of temperatures and strain rates. Prerequisite: E SC 414H or METAL 406.
590. COLLOQUIUM (1-3)
597. SPECIAL TOPICS (1-9)

POLYMER SCIENCE OPTION

The Graduate Faculty

David Allara, Ph.D. (UCLA) *Professor of Materials Science and Chemistry*

T. C. (Mike) Chung, Ph.D. (Penn) *Professor of Polymer Science*

Ralph H. Colby, Ph.D. (Northwestern) *Associate Professor of Polymer Science*

Michael M. Coleman, Ph.D. (Case Western Reserve) *Professor of Polymer Science*

Ian R. Harrison, Ph.D. (Case Western Reserve) *Professor of Polymer Science*

Sanat Kumar, Ph.D. (MIT) *Professor of Polymer Science*

Evangelos Manias, Ph.D. (Groningen) *Assistant Professor of Materials Science and Engineering*

Paul C. Painter, Ph.D. (Case Western Reserve) *Professor of Polymer Science*

James P. Runt, Ph.D. (Penn State) *Professor of Polymer Science*

This program is one of the advanced degree options in the Department of Materials Science and Engineering. Polymer Science is a multidisciplinary subject primarily concerned with the study of macromolecules (chain-like molecules of a very high molecular weight). Polymeric materials are pervasive in today's technological society and find numerous applications in such diverse fields as plastics, elastomers (rubber), adhesives, surface coatings (paints), textiles, paper, packaging, and composites. Research facilities are available for studies involving the synthesis, chemical and physical characterization, surface studies, and theoretical modeling of polymeric materials. Special instrumentation exists for research in the areas of vibrational spectroscopy, thermal analysis, X-ray scattering, surface studies, and mechanical testing.

Graduates with advanced degrees in Polymer Science are prepared for research and development careers in numerous academic, industrial, and government organizations involved with polymeric materials.

MATHEMATICS

POLYMER SCIENCE AND ENGINEERING (PLMSE)

- 400. POLYMERIC MATERIALS I (3)
- 401. POLYMER SYNTHESIS (3)
- 406. INTRODUCTION TO THE MATERIALS SCIENCE OF POLYMERS (3)
- 407. SOLID STATE PROPERTIES OF POLYMERIC MATERIALS (3)
- 409. THERMODYNAMICS, MICROSTRUCTURE, AND CHARACTERIZATION OF POLYMERS (3)
- 410. MECHANICAL AND ELECTRICAL PROPERTIES AND PROCESSING OF POLYMERS AND COMPOSITES (3)
- 412. POLYMERIC MATERIALS LABORATORY—SYNTHESIS (1)
- 413. POLYMERIC MATERIALS LABORATORY—CHARACTERIZATION (1)
- 416. THERMODYNAMICS OF POLYMER SYSTEMS (3)
- 419. ADVANCED PROCESSING TECHNOLOGY (9)
- 442. RHEOLOGY AND PROCESSING OF POLYMERS (3)
- 496. SENIOR RESEARCH (1–6)
- 497. SPECIAL TOPICS (1–9)

POLYMER SCIENCE (PLMSC)

- 500. POLYMERIC MATERIALS I (3) In-depth discussions of the synthesis and properties of both novel and industrially significant polymers prepared by condensation polymerization. Prerequisite: PLMSC 401.
- 501. POLYMERIC MATERIALS II (3) In-depth discussions of the synthesis and properties of polymers prepared by free radical, anionic and cationic polymerization. Prerequisite: PLMSC 401.
- 510. MULTICOMPONENT POLYMER SYSTEMS (3) A study of multicomponent polymer systems, including miscible and immiscible blends, interpenetrating networks, and block copolymers. Prerequisite: PLMSC 406.
- 520. CRYSTALLINE POLYMERS (3) Morphology, characterization, and properties of crystalline polymers, including polymer crystals. Advanced characterization techniques as applied to crystalline polymers. Prerequisite: PLMSC 407.
- 522. SPECTROSCOPY OF MOLECULAR MATERIALS (3) Theory and applications of molecular spectroscopy to condense-phase systems, particularly solid-state organic materials. Prerequisite: CHEM 452 or equivalent.
- 524. SURFACES AND INTERFACES OF ORGANIC MATERIALS (3) Characterization of the structure and properties of interfaces between organic materials and metals, semiconductors. Prerequisite: CHEM 452 or equivalent.
- 530. STRUCTURE AND CONFORMATIONS OF MACROMOLECULES (3) Discussion of statistical mechanics, structure, conformations, and dynamics of polymers; polymers near surfaces; scaling concepts and renormalization group theory. Prerequisite: PLMSC 409.
- 590. COLLOQUIUM (1–3)
- 596. INDIVIDUAL STUDIES (1–9)
- 597. SPECIAL TOPICS (1–9)

MATHEMATICS (MATH)

SVETLANA KATOK, *In Charge of Graduate Programs in Mathematics*
224 McAllister Building
814-865-7529

Degrees Conferred: Ph.D., D.Ed., M.A., M.Ed.

The Graduate Faculty

Joel H. Anderson, Ph.D. (Indiana) *Professor of Mathematics*
George E. Andrews, Ph.D. (Pennsylvania) *Evan Pugh Professor of Mathematics*
Steve Armentrout, Ph.D. (Texas, Austin) *Professor of Mathematics*
Douglas N. Arnold, Ph.D. (Chicago) *Distinguished Professor of Mathematics*
Augustin Banyaga, Ph.D. (Geneva) *Professor of Mathematics*
Paul F. Baum, Ph.D. (Princeton) *Evan Pugh Professor of Mathematics*
Andrew Belmonte, Ph.D. (Princeton) *Assistant Professor of Mathematics*
Leonid Berlyand, Ph.D. (Kharkov State) *Assistant Professor of Mathematics*

W. Dale Brownawell, Ph.D. (Cornell) *Distinguished Professor of Mathematics*
 Jean-Luc Brylinski, These d'Etat (Paris, Sud) *Professor and Eberly Chair in Mathematics*
 Rance K. Brylinski, Ph.D. (MIT) *Professor of Mathematics*
 Dmitri Burago, Ph.D. (St. Petersburg State) *Associate Professor of Mathematics*
 Maria-Carme Calderer, Ph.D. (Heriot-Watt University) *Professor of Mathematics*
 Wenwu Cao, Ph.D. (Penn State) *Associate Professor of Mathematics and Materials*
 Min Chen, Ph.D. (Indiana) *Assistant Professor of Mathematics*
 Frank R. Deutsch, Ph.D. (Brown) *Professor of Mathematics*
 Edward Formanek, Ph.D. (Rice) *Professor of Mathematics*
 Moses Glasner, Ph.D. (California, Los Angeles) *Associate Professor of Mathematics*
 Dima Grigoriev, Ph.D. (Stanford) *Professor of Mathematics, and Computer Science and Engineering*
 Diane M. Henderson, Ph.D. (California, San Diego) *Associate Professor of Mathematics*
 Nigel Higson, Ph.D. (Dalhousie) *Professor of Mathematics*
 Robert P. Hunter, Ph.D. (Louisiana State) *Professor of Mathematics*
 Donald G. James, Ph.D. (MIT) *Professor of Mathematics*
 Thomas Jech, Ph.D. (Prague) *Professor of Mathematics*
 Anatole Katok, Ph.D. (Moscow State) *Professor of Mathematics*
 Svetlana Katok, Ph.D. (Maryland) *Professor of Mathematics*
 Allan M. Krall, Ph.D. (Virginia) *Professor of Mathematics*
 Gerald Lallement, Doctorat es Mathematiques (Paris) *Professor of Mathematics*
 Marc Levi, Ph.D. (Courant) *Professor of Mathematics*
 Jenny Xiaoe Li, Ph.D. (Cornell) *Assistant Professor of Mathematics and Economics*
 L. C. Li, Ph.D. (Courant) *Associate Professor of Mathematics*
 W. C. Li, Ph.D. (California, Berkeley) *Professor of Mathematics*
 Chun Liu, Ph.D. (Courant) *Assistant Professor of Mathematics*
 Richard B. Mansfield, Ph.D. (Stanford) *Associate Professor of Mathematics*
 Peter Maserich, Ph.D. (Maryland) *Professor of Mathematics*
 Mary McCammon, Ph.D. (London) *Professor of Mathematics*
 Gary L. Mullen, Ph.D. (Penn State) *Professor of Mathematics*
 Victor Nistor, Ph.D. (California, Berkeley) *Professor of Mathematics*
 Adrian Ocneanu, Ph.D. (Warwick) *Professor of Mathematics*
 Ken Ono, Ph.D. (UCLA) *Assistant Professor of Mathematics*
 Yakov Pesin, Ph.D. (Moscow State) *Professor of Mathematics*
 Amitai Regev, Ph.D. (Hebrew) *Professor of Mathematics*
 John Roe, D.Phil. (Oxford) *Professor of Mathematics*
 Jie Shen, Ph.D. (Paris, Sud) *Associate Professor of Mathematics*
 David A. Sibley, Ph.D. (Cal. Tech.) *Associate Professor of Mathematics*
 Stephen G. Simpson, Ph.D. (MIT) *Professor of Mathematics*
 Gregory Swiatek, Ph.D. (Warsaw) *Professor of Mathematics*
 Simon J. Tavenner, Ph.D. (Oxford) *Associate Professor of Mathematics*
 Arkady Tempelman, Ph.D. (Vilnius) *Professor of Mathematics and Statistics*
 Boris Tsygan, Ph.D. (Moscow State) *Professor of Mathematics*
 Leonid N. Vaserstein Ph.D. (Moscow State) *Professor of Mathematics*
 Roger P. Ware, Ph.D. (California, Santa Barbara) *Professor of Mathematics*
 William C. Waterhouse, Ph.D. (Harvard) *Professor of Mathematics*
 Howard Weiss, Ph.D. (Maryland) *Associate Professor of Mathematics*
 Robert Wells, Ph.D. (Princeton) *Professor of Mathematics*
 Jinchao Xu, Ph.D. (Cornell) *Professor of Mathematics*
 Ping Xu, Ph.D. (California, Berkeley) *Associate Professor of Mathematics*
 Yuri G. Zarhin, Ph.D. (Leningrad State) *Professor of Mathematics*

Graduate courses in all the principal branches of mathematics are offered regularly each year. The department is prepared to direct research in a variety of fields, including various branches of analysis, algebra, topology, number theory, applied analysis, and mathematical logic and foundations.

Admission Requirements

Scores from the Graduate Record Examination Aptitude Test (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. Requirements listed here are in addition to general

Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

To be admitted to the Ph.D., D.Ed., or M.A. program without undergraduate deficiency, an applicant should have completed at least 18 credits in mathematics at the advanced undergraduate level (400 series or their equivalents). The undergraduate student is urged to take at least 6 credits in foundations of analysis (MATH 401), 6 in modern algebra (MATH 435-436), and 3 in topology (MATH 429) or their equivalents. These courses are essential preparation for the graduate program, and if they are taken after admission, a maximum of 6 credits may be counted toward an advanced degree.

Students with a 3.00 junior/senior average and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

Entering graduate students in mathematics for whom English is not the first language are required to have a score of at least 550 on the TOEFL (Test of English as a Foreign Language) examination. Furthermore, the results of this examination must be received by the Department of Mathematics at least six months prior to the requested date of admission to the Graduate School.

Master's Degree Requirements

For the M.A. degree the department offers two options: (1) the thesis option requires 12 credits of approved 500-series course in mathematics, 6 to 9 credits of thesis, sufficient credits in approved 400- or 500-series courses to make a total of 30 credits, and a final oral examination based on the thesis and general course material; and (2) the nonthesis option requires 18 credits of 500-series courses in mathematics, sufficient credits in approved 400- or 500-series courses to make a total of 30 credits, and a term paper on an approved topic in mathematics. No final examination is given in this option. Under this option a student may also elect to take a minor in applied mathematics (9 credits with at least 6 at the 500 level) and may use these credits toward the necessary 30 credits. For both options, a grade of A or B is required in all courses.

To be admitted to the M.Ed. program without undergraduate deficiency, an applicant should have completed at least 15 credits in mathematics at the intermediate level beyond calculus. The M.Ed. program does not require any 500-series courses, but the student is encouraged to select some at this level. Special courses have been instituted for the training of teachers. Among these are MATH 470, and 471. These are acceptable to satisfy credit requirements only for the M.Ed. degree.

Doctoral Degree Requirements

All doctoral students are required to take three qualifying examinations. Two of these examinations must be completed prior to the beginning of the student's second year of graduate study, and the third prior to the beginning of the third year. The qualifying examinations are in the areas of analysis, algebra, and topology/geometry, unless a student chooses to enroll in the Applied Mathematics option or the Logic and Foundations option. For the Applied Mathematics option, the qualifying examinations are in the areas of analysis, numerical analysis, and partial differential equations, and for the Logic and Foundations option, the areas are analysis, algebra, and logic and foundations. Students who wish to enroll in the Applied Mathematics option or the Logic and Foundations option must file a petition with the Graduate Studies Committee anytime between admission to the Ph.D. program and the add/drop deadline for the student's first semester.

The qualifying examinations are given twice a year—after the end of the spring semester and before the beginning of the fall semester. Basic, one-year sequences are offered in each subject annually to help students prepare for the examinations. Typically, an entering Ph.D. student takes two of the basic sequences in the first year and the third basic sequence in the second year of study, and takes the qualifying examinations in the spring after completing the corresponding courses. If an examination is failed, the student must take it again. Students who fail a qualifying examination in a given subject twice may not continue in the Ph.D. program.

Entering Ph.D. students may take one or more of the qualifying examinations on arrival in August without penalty. If they fail a pre-entrance exam, they still have two more opportunities to pass it. Entering Ph.D. students are advised to take at least two basic sequences (in the subjects they did not pass qualifying exams in on arrival) and the subsequent qualifying exams in the first year of graduate study.

After passing all three qualifying exams, students are expected to select a thesis adviser and form a doctoral committee. The committee administers the comprehensive exam (no later than the end of the seventh semester of study) and offers counsel of the student as his research progresses.

Other Relevant Information

Students in this program may elect the dual-title degree program option in Operations Research for the Ph.D. and M.S. degrees. (*See also* Operations Research.)

A brochure describing more fully the graduate program in Mathematics is available from the Department of Mathematics.

Student Aid

Graduate assistantships available through this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

MATHEMATICS (MATH)

- 401. INTRODUCTION TO ANALYSIS I (3)
- 403. CLASSICAL ANALYSIS I (3)
- 404. CLASSICAL ANALYSIS II (3)
- *405. ADVANCED CALCULUS FOR ENGINEERS AND SCIENTISTS I (3)
- 406. ADVANCED CALCULUS FOR ENGINEERS AND SCIENTISTS II (3)
- 411. ORDINARY DIFFERENTIAL EQUATIONS (3)
- 412. FOURIER SERIES AND PARTIAL DIFFERENTIAL EQUATIONS (3)
- 414. (STAT) INTRODUCTION TO PROBABILITY THEORY (3)
- 415. (STAT) INTRODUCTION TO MATHEMATICAL STATISTICS (3)
- 416. (STAT) STOCHASTIC MODELING (3)
- 417. QUALITATIVE THEORY OF DIFFERENTIAL EQUATIONS (3)
- 418. (STAT) PROBABILITY (3)
- 419. (PHYS) THEORETICAL MECHANICS (3)
- 421. COMPLEX ANALYSIS (3)
- 426. INTRODUCTION TO MODERN GEOMETRY (3)
- 427. FOUNDATIONS OF GEOMETRY (3)
- 429. INTRODUCTION TO TOPOLOGY (3)
- 435. BASIC ABSTRACT ALGEBRA (3)
- 436. LINEAR ALGEBRA (3)
- 437. ALGEBRAIC GEOMETRY (3)
- *441. MATRIX ALGEBRA (3)
- 451. (CSE) NUMERICAL COMPUTATIONS (3)
- 455. (CSE) INTRODUCTION TO NUMERICAL ANALYSIS I (3)
- 456. (CSE) INTRODUCTION TO NUMERICAL ANALYSIS II (3)
- 457. INTRODUCTION TO MATHEMATICAL LOGIC (3)
- 459. COMPUTABILITY AND UNSOLVABILITY (3)
- 461. (PHYS) THEORETICAL MECHANICS (3)
- 465. NUMBER THEORY (3)
- 467. (CSE) FACTORIZATION AND PRIMARITY TESTING (3)
- 468. MATHEMATICAL CODING THEORY (3)
- 469. MATHEMATICS OF ALGORITHMS (3)
- *470. ALGEBRA FOR TEACHERS (3)
- *471. GEOMETRY FOR TEACHERS (3)
- 483. APPLIED MODERN ALGEBRA II (3)
- 484. LINEAR PROGRAMS AND RELATED PROBLEMS (3)
- 485. GRAPH THEORY (3)
- 486. MATHEMATICAL THEORY OF GAMES (3)
- 496. INDEPENDENT STUDIES (3)
- 497. SPECIAL TOPICS (3)
- 499. FOREIGN STUDIES (1-12)

501. COMPLEX AND REAL ANALYSIS I (3) Cauchy's theorem, Laurent expansion, residue calculus, harmonic functions, conformal mapping, measure and integration, convergence theorems, L^p spaces, Hilbert spaces. Prerequisite: MATH 404.

502. COMPLEX AND REAL ANALYSIS II (3) Fourier analysis, Fubini's theorem, Hahn-Banach theorem, open mapping theorem, uniform boundedness principle, dual spaces, selected topics from functional analysis. Prerequisite: MATH 501.

503. FUNCTIONAL ANALYSIS (3) Topological vector spaces, completeness, convexity, duality, Banach algebras, bounded operators on Hilbert space, the spectral theorem, unbounded operators, applications. Prerequisite: MATH 502.
504. ANALYSIS IN EUCLIDEAN SPACE (3) The Fourier transform in L^1 and L^2 applications, interpolation of operators, Riesz and Marcinkiewicz theorems, singular integral operators. Prerequisite: MATH 502.
505. MATHEMATICAL FLUID MECHANICS (3) Kinematics, balance laws, constitutive equations. Ideal fluids, viscous flows, boundary layers, lubrication. Gas dynamics. Prerequisite: MATH 402 or 404.
506. ERGODIC THEORY (3) Measure-preserving transformations and flows, ergodic theorems, ergodicity, mixing, weak mixing, spectral invariants, measurable partitions, entropy, Ornstein isomorphism theory. Prerequisite: MATH 502.
507. DYNAMICAL SYSTEMS I (3) Fundamental concepts. Extensive survey of examples. Equivalence and classification of dynamical systems, principal classes of asymptotic invariants, circle maps. Prerequisite: MATH 502.
508. DYNAMICAL SYSTEMS II (3) Hyperbolic theory. Stable manifolds, hyperbolic sets, attractors, Anosov systems, shadowing, structural stability, entropy, pressure, Lyapunov characteristic exponents and nonuniform hyperbolicity. Prerequisite: MATH 507.
509. LINEAR ANALYSIS AND APPLICATIONS I (3) Vector spaces, linear transformations, integration, Fourier and Laplace transforms, distributions, differential operators. Prerequisite: MATH 401, 411, or 412.
510. LINEAR ANALYSIS AND APPLICATIONS II (3) Integral equations, compact operators, variational methods, partial differential equations. Prerequisite: MATH 509.
511. ORDINARY DIFFERENTIAL EQUATIONS I (3) Existence and uniqueness, linear systems, series methods, Poincaré-Bendixson theory, stability. Prerequisite: MATH 411 or 412.
512. ORDINARY DIFFERENTIAL EQUATIONS II (3) Floquet theory, regular and singular boundary value problems, Green's functions, eigenfunction expansions. Prerequisite: MATH 511.
513. PARTIAL DIFFERENTIAL EQUATIONS I (3) First-order equations, the Cauchy problem, Cauchy-Kowalevski theorem, Laplace equation, wave equation, heat equation. Prerequisite: MATH 411 or 412.
514. PARTIAL DIFFERENTIAL EQUATIONS II (3) Sobolev spaces and elliptic boundary value problems, Schauder estimates, quasilinear symmetric hyperbolic systems, conservation laws. Prerequisites: MATH 502, 513.
515. CLASSICAL MECHANICS AND VARIATIONAL METHODS (3) Introduction to the calculus of variations, variational formulation of Lagrangian mechanics, symmetry in mechanical systems, Legendre transformation, Hamiltonian mechanics, completely integrable systems. Prerequisite: MATH 401, 411, or 412.
516. (STAT) STOCHASTIC PROCESSES (3) Markov Chains; generating functions; limit theorems; continuous time and renewal processes; martingales, submartingales, and supermartingales; diffusion processes; applications. Prerequisite: MATH (STAT) 416.
517. (STAT) PROBABILITY THEORY I (3) Measure theoretic foundation of probability, distribution functions and laws, types of convergence, central limit problem, conditional probability, special topics. Prerequisite: MATH 502.
518. (STAT) PROBABILITY THEORY II (3) Measure theoretic foundations of probability, distribution functions and laws, types of convergence, central limit problem, conditional probability, special topics. Prerequisite: MATH 517.
519. (STAT) TOPICS IN STOCHASTIC PROCESSES (3) Selected topics in stochastic processes, including Markov and Wiener processes; stochastic integrals, optimization, and control; optimal filtering. Prerequisites: MATH (STAT) 516, 517.
520. INTRODUCTION TO OPERATOR ALGEBRAS (3) Basic properties of C^* -algebras, classification of von Neumann algebras into types, functionals and representations, tensor products, automorphisms, crossed products. Prerequisite: MATH 503.
521. COMPLEX ANALYSIS: THEORY AND APPLICATIONS I (3) Conformal mappings, Schwarz-Cristoffel transformations, Dirichlet and Neumann problems, electrostatics and fluid flow, transform methods, asymptotic methods, Runge approximation theorems. Prerequisite: MATH 502.
522. COMPLEX ANALYSIS: THEORY AND APPLICATIONS II (3) Factorization theorems, prime number theorem, Mittag-Leffler theorem, Nevanlinna theory, Riemann surfaces, Hartog's theorems, holomorphic mappings and automorphisms of bounded domains. Prerequisite: MATH 521.
525. THEORY OF FUNCTIONS OF SEVERAL COMPLEX VARIABLES (3) Fundamental properties of holomorphic functions, reproducing kernels, integral representations, domain of holomorphy and pseudoconvexity, Weierstrass preparation theorem, complex manifolds. Prerequisite: MATH 502.

527. GEOMETRY AND TOPOLOGY I (3) Topological spaces and continuous mappings, connectedness, compactness and separation, fundamental groups, Jordan curve theorem, singular homology, Brouwer Fixed Point theorem. Prerequisites: MATH 429.
528. GEOMETRY AND TOPOLOGY II (3) Manifolds, differentiable structures, implicit function theorem, vector fields and differential equations, differential forms, Poincare Lemma, integration, Stokes theorem, deRham's theorem. Prerequisite: MATH 527.
529. ALGEBRAIC TOPOLOGY (3) Manifolds, Poincare duality, vector bundles, Thom isomorphism, characteristic classes, classifying spaces for vector bundles, discussion of bordism, as time allows. Prerequisite: MATH 528.
530. DIFFERENTIAL GEOMETRY (3) Distributions and Frobenius theorem, curvature of curves and surfaces, Riemannian geometry, connections, curvature, Gauss-Bonnet theorem, geodesics and completeness. Prerequisite: MATH 528.
531. DIFFERENTIAL TOPOLOGY (3) DeRham's theorem, geometry of smooth mappings, critical values, Sard's theorem, Morse functions, degree of mappings, smooth fiber bundles. Prerequisite: MATH 528.
533. LIE THEORY I (3) Lie groups, Lie algebras, exponential mappings, subgroups, subalgebras, simply connected groups, adjoint representation, semisimple groups, infinitesimal theory, Cartan's criterion. Prerequisite: MATH 528.
534. LIE THEORY II (3) Representations of compact Lie groups and semisimple Lie algebras, characters, orthogonality, Peter-Weyl theorem, Cartan-Weyl highest weight theory. Prerequisite: MATH 533.
- 535-536. ALGEBRA (3 each) Permutation groups, Sylow theorems, Jordan-Hölder theorem, polynomial rings, unique factorization domains, algebraic and transcendental field extensions, Galois theory. Prerequisites: MATH 435 and a course in linear algebra (for MATH 535 only); MATH 535 (for MATH 536 only).
537. FIELD THEORY (3) Finite and infinite algebraic extensions; cyclotomic fields; transcendental extensions; bases of transcendence, Luroth's theorem, ordered fields, valuations; formally real fields. Prerequisite: MATH 536.
538. COMMUTATIVE ALGEBRA (3) Topics selected from Noetherian rings and modules, primary decompositions, Dedekind domains and ideal theory, other special types of commutative rings or fields. Prerequisite: MATH 536.
- 539-540. RING THEORY (3 each) Selected topics including Noetherian and Artinian modules and rings, semisimple rings, Wedderburn theorems, Jacobson radical and density theorem. Prerequisite: MATH 536 (for MATH 539 only); MATH 539 (for MATH 540 only).
- 542-543. GROUP THEORY I AND II (3 each) Topics selected by instructor from abelian, solvable, and nilpotent groups; finite presentations; free products; group extensions; group representations. Prerequisite: MATH 535 (for MATH 542 only); MATH 542 (for MATH 543 only).
544. APPLIED ALGEBRA (3) Basic algorithms of algebra, application to number theory, group theory, field theory, linear algebra, and combinatorics. Prerequisites: MATH 435, 436, and ability to use a computer.
546. SEMIGROUP THEORY AND APPLICATIONS (3) Basic algebraic properties of semigroups, finite transformation semigroups, free semigroups, formal languages, and combinatorics. Prerequisites: MATH 435, 535.
547. ALGEBRAIC GEOMETRY I (3) Affine and projective algebraic varieties, Zariski topology, Hilbert Nullstellensatz, regular functions and maps, birationality, smooth varieties, normalization, dimension. Prerequisite: MATH 536.
548. ALGEBRAIC GEOMETRY II (3) Topics may include: algebraic curves, Riemann-Roch theorem, linear systems and divisors, intersection theory, schemes, sheaf cohomology, algebraic groups. Prerequisite: MATH 547.
549. MATHEMATICAL PROGRAMMING (3) Quadratic and convex programming, Integer and combinatorial programming, dynamic and stochastic programming. Prerequisite: MATH 484.
550. (CSE) NUMERICAL LINEAR ALGEBRA (3) Solution of linear systems, sparse matrix techniques, linear least squares, singular value decomposition, numerical computation of eigenvalues and eigenvectors. Prerequisite: MATH (CSE) 456 or 441.
551. (CSE) NUMERICAL SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS (3) Methods for initial value and boundary value problems; convergence and stability analysis, automatic error control, stiff systems, boundary value problems. Prerequisites: MATH 411; MATH (CSE) 451 or 456.
552. (CSE) NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS (3) Finite difference methods for elliptic, parabolic, and hyperbolic differential equations; solutions techniques for discretized systems; finite element methods for elliptic problems. Prerequisites: MATH 402 or 404; MATH (CSE) 451 or 456.

553. (CSE) INTRODUCTION TO APPROXIMATION THEORY (3) Interpolation; remainder theory; approximation of functions; error analysis; orthogonal polynomials; approximation of linear functionals; functional analysis applied to numerical analysis. Prerequisites: MATH 401, 3 credits of computer science and engineering.
554. APPROXIMATION THEORY (3) Approximation in normed spaces; existence, uniqueness, characterization, computation of best approximations; error bounds; degree of approximation; approximation of linear functionals. Prerequisites: MATH (CSE) 451 or 456, MATH 501.
555. (CSE 536) NUMERICAL OPTIMIZATION TECHNIQUES (3) Unconstrained and constrained optimization methods, linear and quadratic programming, software issues, ellipsoid and Karmarkar's algorithm, global optimization, parallelism in optimization. Prerequisite: MATH (CSE) 456.
556. (CSE) FINITE ELEMENT METHODS (3) Sobolev spaces, variational formulations of boundary value problems; piecewise polynomial approximation theory, convergence and stability, special methods and applications. Prerequisite: MATH 502, 552.
557. MATHEMATICAL LOGIC (3) The predicate calculus; completeness and compactness; Gödel's first and second incompleteness theorems; introduction to model theory; introduction to proof theory. Prerequisite: MATH 435 or 457.
558. FOUNDATIONS OF MATHEMATICS I (3) Decidability of the real numbers. Computability. Undecidability of the natural numbers. Models of set theory. Axiom of choice, Continuum hypothesis. Prerequisite: any 400-level MATH course or equivalent.
- 559–560. RECURSION THEORY I, II (3 each) Recursive functions, degrees of unsolvability. Hyperarithmetic theory; applications to Borel combinatorics. Computational complexity. Combinatory logic and the lambda calculus. Prerequisite: MATH 459, 557, or 558.
- 561–562. SET THEORY I, II (3 each) Models of set theory. Inner models, forcing, large cardinals, determinacy. Descriptive set theory. Applications to analysis. Prerequisite: MATH 557 or 558.
- 563–564. MODEL THEORY I, II (3 each) Interpolation and definability; prime and saturated models; stability; additional topics; applications to algebra. Prerequisite: MATH 557.
565. FOUNDATIONS OF MATHEMATICS II (3) Subsystems of second order arithmetic. Set existence axioms. Reverse mathematics. Foundations of analysis and algebra. Prerequisites: MATH 557, 558.
- 567–568. NUMBER THEORY I, II (3 each) Congruences, quadratic residues, arithmetic functions, partitions, classical multiplicative ideal theory, valuations and p -adic numbers, primes in arithmetic progression, distribution of primes. Prerequisite: MATH 435 (for MATH 567 only); MATH 567 and prerequisite or concurrent: MATH 421 (for MATH 568 only).
569. ALGEBRAIC NUMBER THEORY I (3) Dedekind rings; cyclotomic and Kummer extensions; valuations; ramification; decomposition, inertial groups; Galois extensions; locally compact groups of number theory. Prerequisite: MATH 536, 568.
570. ALGEBRAIC NUMBER THEORY II (3) Topics chosen from class field theory; integral quadratic forms; algebraic and arithmetic groups; algebraic functions of one variable. Prerequisite: MATH 569.
571. ANALYTIC NUMBER THEORY I (3) Improvements of the prime number theorem, L -functions and class numbers, asymptotic and arithmetic properties of coefficients of modular forms. Prerequisites: MATH 421, 568.
572. ANALYTIC NUMBER THEORY II (3) Distribution of primes, analytic number theory in algebraic number fields, transcendental numbers, advanced theory of partitions. Prerequisite: MATH 571.
574. TOPICS IN LOGIC AND FOUNDATIONS (3–6 per semester) Topics in mathematical logic and the foundations of mathematics. Prerequisite: MATH 558.
577. (M E) STOCHASTIC SYSTEMS FOR SCIENCE AND ENGINEERING (3) The course develops the theory of stochastic processes and linear and nonlinear stochastic differential equations for applications to science and engineering. Prerequisites: MATH 414 or 418; M E 550 or MATH 501.
588. (CSE) COMPLEXITY IN COMPUTER ALGEBRA (3) complexity of integer multiplication, polynomial multiplication, fast Fourier transform, division, and calculating the greatest common divisor of polynomials. Prerequisite: CSE 465.
590. COLLOQUIUM (1–3)
596. INDIVIDUAL STUDIES (1–9)
597. SPECIAL TOPICS (1–9)
598. SPECIAL TOPICS (1–9)
599. FOREIGN STUDIES (1–12 per semester, maximum of 24)

MECHANICAL ENGINEERING (M E)

RICHARD C. BENSON, *Head of the Department*
137 Reber Building
814-865-2519

Degrees Conferred: Ph.D., M.S., M.Eng.

The Graduate Faculty

Thomas Adamek, Ph.D. (Stuttgart) *Adjunct Professor of Mechanical Engineering*
Frank S. Archibald, Ph.D. (Cambridge) *Senior Research Associate, Applied Research Laboratory*
Ashok D. Belegundu, Ph.D. (Iowa) *Professor of Mechanical Engineering*
James G. Brasseur, Ph.D. (Stanford) *Professor of Mechanical Engineering*
John E. Brighton, Ph.D. (Purdue) P.E. *Executive Vice President and Provost; Professor of Mechanical Engineering*
Marc Carpino, Ph.D. (Columbia) *Associate Professor of Mechanical Engineering*
Liming Chang, Ph.D. (Illinois) *Associate Professor of Mechanical Engineering*
Fan-Bill Cheung, Ph.D. (Notre Dame) *Professor of Mechanical Engineering*
John M. Cimbala, Ph.D. (Cal. Tech.) *Professor of Mechanical Engineering*
John E. Dzielski, Ph.D. (MIT) *Research Associate, Applied Research Laboratory*
Gerard M. Faeth, Ph.D. (Penn State) *Professor Emeritus of Mechanical Engineering*
Mary I. Frecker, Ph.D. (Michigan) *Assistant Professor of Mechanical Engineering*
John F. Gardner, Ph.D. (Ohio State) P.E. *Associate Professor of Mechanical Engineering*
Teddick A. Harris, M.S. (Penn State) *Professor of Mechanical Engineering*
Robert J. Heinsohn, Ph.D. (Michigan State) P.E. *Professor Emeritus of Mechanical Engineering*
Robert E. Henderson, Ph.D. (Cambridge) P.E. *Professor Emeritus of Mechanical Engineering*
John J. Henry, Sc.D. (MIT) *Professor of Mechanical Engineering*
Lawrence E. Hochreiter, Ph.D. (Purdue) *Professor of Mechanical Engineering and Nuclear Engineering*
Thomas G. Hughes, Ph.D. (Penn State) *Research Associate, Applied Research Laboratory*
Harold R. Jacobs, Ph.D. (Ohio State) P.E. *Professor of Mechanical Engineering*
Suresh M. Joshi, Ph.D. (Rensselaer Polytechnic Inst.) *Adjunct Professor of Mechanical Engineering*
Gary H. Koopmann, Ph.D. (Catholic University) *Distinguished Professor of Mechanical Engineering*
Bohdan Kulakowski, Ph.D. (Inst of Applied Cybernetics) *Professor of Mechanical Engineering*
Anil K. Kulkarni, Ph.D. (Brown) *Professor of Mechanical Engineering*
Kenneth K. Kuo, Ph.D. (Princeton) *Distinguished Professor of Mechanical Engineering*
John S. Lamancusa, Ph.D. (Wisconsin, Madison) *Associate Professor of Mechanical Engineering*
Brian E. Launder, Sc.D. (MIT); D.Sc. (U. London) *Adjunct Professor of Mechanical Engineering*
Samuel S. Lestz, Ph.D. (Wisconsin) *Professor Emeritus of Mechanical Engineering*
Thomas A. Litzinger, Ph.D. (Princeton) *Professor of Mechanical Engineering*
Eric R. Marsh, Ph.D. (MIT) *Assistant Professor of Mechanical Engineering*
Henry McDonald, Ph.D. (Glasgow) *Senior Research Associate, Applied Research Laboratory; Professor of Mechanical Engineering*
Panagiotis Michaleris, Ph.D. (Illinois) *Assistant Professor of Mechanical Engineering*
Timothy F. Miller, Ph.D. *Research Associate, Applied Research Laboratory*
Michael F. Modest, Ph.D. (California, Berkeley) *Professor of Mechanical Engineering*
Timothy C. Ovaert, Ph.D. (Northwestern) *Associate Professor of Mechanical Engineering*
William H. Park, Ph.D. (Cornell) *Professor Emeritus of Mechanical Engineering*
Laura L. Pauley, Ph.D. (Stanford) *Associate Professor of Mechanical Engineering*
Horacio Perez-Blanco, Ph.D. (Illinois) *Professor of Mechanical Engineering*
Howard L. Petrie, Ph.D. (Illinois) *Research Associate, Applied Research Laboratory*
Asok Ray, Ph.D. (Northeastern) *Professor of Mechanical Engineering*
Gerhard Reethof, Sc.D. (MIT) *Professor Emeritus of Mechanical Engineering*
Domenic A. Santavicca, Ph.D. (Princeton) *Professor of Mechanical Engineering*
Robert J. Santoro, Ph.D. (Boston College) *Professor of Mechanical Engineering*
Frank W. Schmidt, Ph.D. (Wisconsin) *Professor Emeritus of Mechanical Engineering*
Gary S. Settles, Ph.D. (Princeton) *Professor of Mechanical Engineering*
Alok Sinha, Ph.D. (Carnegie Mellon) *Professor of Mechanical Engineering*
Richard B. Smith, Ph.D. (Penn State) *Research Associate, Applied Research Laboratory*
H. Joseph Sommer III, Ph.D. (Illinois) *Professor of Mechanical Engineering*

Donald A. Streit, Ph.D. (Purdue) *Professor of Mechanical Engineering*
Gita Talmage, Ph.D. (Louisiana) *Associate Professor of Mechanical Engineering*
Stefan T. Thynell, Ph.D. (North Carolina State) *Professor of Mechanical Engineering*
Martin W. Trethewey, Ph.D. (Michigan Tech) *Professor of Mechanical Engineering*
Stephen R. Turns, Ph.D. (Wisconsin) *Professor of Mechanical Engineering*
Jeremy L. Webb, Ph.D. (Penn State) *Research Associate, Applied Research Laboratory*
James C. Wambold, Ph.D. (New Mexico) *Professor Emeritus of Mechanical Engineering*
Chao-Yang Wang, Ph.D. (Iowa) *Assistant Professor of Mechanical Engineering*
Kon-Well Wang, Ph.D. (California, Berkeley) *Professor of Mechanical Engineering*
Ralph L. Webb, Ph.D. (Minnesota) *Professor of Mechanical Engineering*
Carl H. Wolgemuth, Ph.D. (Ohio State) *Professor Emeritus of Mechanical Engineering*
David N. Wormley, Ph.D. (MIT) *Professor and Dean of Engineering*
John Wyngaard, Ph.D. (Penn State) *Professor of Meteorology and GeoEnvironmental/Mechanical Engineering*
Vigor Yang, Ph.D. (Cal-Tech) *Professor of Mechanical Engineering*
Savash Yavuzkurt, Ph.D. (Stanford) *Associate Professor of Mechanical Engineering*
Adam M. Yocum II, Ph.D. (Virginia Polytechnic) *Research Associate, Applied Research Laboratory*

Graduate programs and research facilities are available in combustion, heat transfer, fluid mechanics, dynamic system analysis, robotics, mechanical design, and energy systems. Air pollution control, automotive safety, tribology, designing for noise control and for reliability also provide many research and design opportunities.

Admission Requirements

Admission to the program is quite competitive. Entering students must hold a bachelor's degree in engineering or physical science. Students with 3.0 or better (out of 4.0) junior/senior cumulative grade-point averages and appropriate course backgrounds will be considered for admission. The best-qualified applicants will be admitted. In addition, scores from the Graduate Record Examination (GRE) are required, and international student must attain a score of 550 or better on the Test of English as a Foreign Language (TOEFL). Letters of recommendation and a statement of purpose written by the applicant are also required.

Degree Requirements

The M.S. degree program is designed for students to gain advanced knowledge for research, analysis, and design in mechanical engineering. Students pursuing an M.S. degree may choose one of two options: completion of 24 course credits and the submission of a thesis (6 credits) to the Graduate School, or 30 course credits and the submission of a scholarly paper to the department. A Ph.D. thesis proposal may serve as the paper, provided the student has passed the Ph.D. candidacy examination.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by an in-depth study of one foreign language (6 credits), by taking two or more courses (minimum of 6 credits) of a nontechnical nature in a single area of study appropriate and related to the student's career orientation, and presenting a formal proposal for thesis research to the doctoral committee. Generally, a Ph.D. student must have 30 credits above a master's degree before taking the comprehensive examination.

Continuous registration is required of all Ph.D. graduate students until the thesis is approved.

The Ph.D. program emphasizes scholarly research and helps students prepare for research and related careers in industry, government, and academe. Students are admitted to candidacy after passing written and oral examinations. The Ph.D. program is quite flexible, with minimal formal requirements. The Ph.D. is awarded upon completion of a program of advanced study that includes a minimum period of residence, a satisfactory thesis, and the passing of comprehensive and final oral examinations as determined by the student's doctoral committee.

Student Aid

Graduate students are supported by a variety of government and industry fellowships, traineeships, and research and teaching assistantships. Stipends vary depending on the source. Competition for support is extremely keen; however, outstanding students are considered for attractive offers of support, including various fellowships specifically for new students in the College of Engineering. By completing the department's application for financial assistance, you will automatically be considered for a graduate assistantship. To receive full consideration for financial aid, all application materials should be submitted by February 1.

MECHANICAL ENGINEERING (M E)

- 403. ROCKET PROPULSION (3)
- 405. AIR POLLUTION CONTROL SYSTEMS (3)
- 409. GAS TURBINES (3)
- 410. POWER PLANTS (3)
- 411. REFRIGERATION AND AIR CONDITIONING (3)
- 412. HEAT TRANSFER (3)
- 413. INTERNAL COMBUSTION ENGINES (3)
- 414W. ENGINEERING ANALYSIS OF THERMAL SYSTEMS (3)
- 415W. ENGINEERING ANALYSIS FOR MECHANICAL DESIGN (3)
- 416. INTRODUCTION TO COMBUSTION (3)
- 417. THEORY OF ENGINEERING INSTRUMENTS (3)
- 418. PRINCIPLES OF TURBOMACHINERY (3)
- 420. HEAT-EXCHANGER DESIGN (3)
- 421. INTERMEDIATE VISCOUS FLOW (3)
- 434. COMPRESSIBLE FLOW I (3)
- 440. MODELING OF DYNAMIC SYSTEMS (3)
- 450. COMPUTER AIDED ANALYSIS OF MECHANICAL SYSTEMS (3)
- 451. ADVANCED MACHINE DESIGN PROBLEMS (3)
- 452. VEHICLE DYNAMICS (3)
- 454. ADVANCED MACHINE DYNAMICS (3)
- 455. (AERSP) AUTOMATIC CONTROL SYSTEMS (3)
- 456. (I E) INDUSTRIAL ROBOTIC APPLICATIONS (3)
- 458. NOISE CONTROL IN MACHINERY (3)
- 460. RELIABILITY CONCEPTS IN DESIGN (3)
- 461. (E MCH) APPLIED FINITE ELEMENT ANALYSIS (3)
- 462. MECHANICAL ENGINEERING APPLICATIONS OF MICROCOMPUTERS (3)
- 470. FUNDAMENTALS OF AIR POLLUTION (3)
- 494. SENIOR THESIS (1-9)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

504. ADVANCED ENGINEERING THERMODYNAMICS (3-6) Pure and applied thermodynamics including its application to advanced engineering problems; collateral reading and discussion of the classical works on the subject.

505. DESIGN OF AIR POLLUTION CONTROL SYSTEMS (3) Advanced principles of design drawn from professional literature, including mechanical collectors, electrostatic precipitators, filters, scrubbers, and industrial ventilation systems. Prerequisite: M E 405.

512. ADVANCED HEAT TRANSFER—CONDUCTION (3) One- and two-dimensional conduction heat transfer for steady state and transient systems with varying boundary conditions.

513. ADVANCED HEAT TRANSFER—CONVECTION (3) Laminar and turbulent flow heat transfer in natural and forced convection systems.

514. RADIATION HEAT TRANSFER—RADIATION (3) Thermal radiation fundamentals; specular and diffuse systems; differential and integral methods; numerical techniques; industrial applications.

515. TWO-PHASE HEAT TRANSFER (3) Two-phase fluid mechanics and heat transfer processes involving evaporation, boiling, and condensation.

516. COMBUSTION IN PROPULSION SYSTEMS (3) Theoretical formulation and methods of solution of engineering problems and physical processes in chemical propulsion systems.

517. TECHNIQUES FOR HEAT TRANSFER ENHANCEMENT (3) Study of advanced concepts in convective and two-phase heat transfer, with emphasis on techniques of heat transfer enhancement. Prerequisites: M E 033, 412.

518. ANALYSIS OF HEAT EXCHANGER EQUIPMENT (3) Application of theoretical fundamentals to the design of heat exchange equipment, and the analysis of simultaneous heat and mass transfer processes. Prerequisite: M E 513 or 515.

519. COMPRESSIBLE FLOW II (2-4) Two-dimensional subsonic flow; similarity rules; theory of characteristics; transonic, supersonic, and hypersonic flows; compressible boundary layers.

521. FOUNDATIONS IN FLUID MECHANICS I (3) First semester of a core sequence in fluid mechanics; Navier-Stokes equations, potential flow, low Re flow, laminar boundary layers. Prerequisites: M E 30, M E 33.

522. FOUNDATIONS OF FLUID MECHANICS II (3) Second semester of a core sequence in fluid mechanics; continuation of laminar boundary layers, stability, transition, turbulence, turbulent boundary layers, turbulence models. Prerequisites: M E 421 or M E 521.
524. (AERSP) HOMOGENEOUS TURBULENCE (3) First in a two-part series. Similarity and scaling, vorticity dynamics; Fourier spectral representation; interscale energy transfer. Numerical simulations and experimental measurement. Prerequisite: a graduate-level course in fluid mechanics.
525. (AERSP) INHOMOGENEOUS TURBULENCE (3) Second in two-part series. Instability and transition; turbulence models; Reynolds stress closure schemes; large eddy simulations; wave models; turbulence measurements. Prerequisite: M E (AERSP) 524.
526. (AERSP) COMPUTATIONAL METHODS FOR SHEAR LAYERS (3) Study of numerical solution methods for steady and unsteady laminar or turbulent boundary-layer equations in two and three dimensions. Prerequisite: M E 540 or AERSP 423.
527. (AERSP) COMPUTATIONAL METHODS IN TRANSONIC FLOW (3) Numerical solution of partial differential equations of mixed type, with emphasis on transonic flows and separating boundary layers. Prerequisite: M E 540 or AERSP 423.
528. (AERSP) COMPUTATIONAL METHODS FOR RECIRCULATING FLOWS (3) Numerical solution techniques for laminar/turbulent flow with large recirculation zones. Both primitive variable and stream function-vorticity equations used. Prerequisites: AERSP 423, M E 540.
530. SPECIES MEASUREMENTS IN COMBUSTION SYSTEMS (1-3) Study of modern instrumentation techniques for determination of species concentrations in combustion systems.
532. TURBULENT AND TWO-PHASE COMBUSTION (3) Fundamentals of chemically reacting turbulent flows in homogeneous systems, including turbulent flames, spray combustion, ignition, reacting boundary layers. Prerequisite: F SC 421 or M E 516.
535. PHYSICS OF GASES (3) An introduction to kinetic theory, statistical mechanics, quantum mechanics, atomic and molecular structure, chemical thermodynamics, and chemical kinetics.
536. LASER DOPPLER VELOCIMETRY (1) A study of methods for measuring velocities, turbulence quantities, and particle sizes employing laser light scattering principles.
537. LASER DIAGNOSTICS FOR COMBUSTION (3) A study of laser-based techniques for measuring gas temperature and concentration in chemically reacting flows. Prerequisite: M E 535.
540. NUMERICAL SOLUTIONS APPLIED TO HEAT TRANSFER AND FLUID MECHANICS PROBLEMS (3) Application of finite difference methods to the study of potential and viscous flows and conduction and convection heat transfer.
550. FOUNDATIONS OF ENGINEERING SYSTEMS ANALYSIS (3) Analytical methods are developed using the vector space approach for solving control and estimation problems; examples from different engineering applications. Prerequisite: MATH 436.
552. ADVANCED DYNAMICS OF MACHINES (3-6) Linear and torsional vibrations in and balancing of rotating and reciprocating machinery; exact analysis of stresses produced by these and other dynamic forces in machine parts. Prerequisites: E MCH 012, M E 054.
554. EXPERIMENTAL MODAL ANALYSIS (3) The development of structural dynamic models from experimental data, analytical and experimental vibration, analysis methods, laboratory techniques. Prerequisite: M E 440.
555. AUTOMATIC CONTROL SYSTEMS (3) Advanced problems and techniques in the design of automatic control systems with emphasis on stability, controller design, and optimum performance. Prerequisite: M E 455.
556. (I E) ADVANCED ROBOTIC CONCEPTS (3) Analysis of robotic systems; end effectors, vision systems, sensors, stability and control, off-line programming, simulation of robotic systems. Prerequisite: M E 456 or I E 456.
557. MECHANISM SYNTHESIS (3) Geometric and algebraic methods for synthesizing planar and spatial mechanisms, dynamics of spatial mechanism.
559. (E E) NONLINEAR CONTROL AND STABILITY (3) Theory of nonlinear automatic control systems; phase-plane methods; describing functions; Liapunov stability; special topics in stability, nonlinear control systems design with applications to aircraft, power plants, and robotics. Prerequisite: E E 417, 428, or M E 455.
560. DIGITAL PROCESS/DIGITAL CONTROL (3) Analysis and design of control systems with digital controllers, including PID, finite settling time, state feedback, and minimum variance algorithms. Prerequisites: M E 440, 455.
562. SIMULATION OF MECHANICAL SYSTEMS (3) Introduces computational fundamentals, including digital logic; programming language, basic numerical analysis and data processing, as applied to mechanical simulation techniques. Prerequisites: M E 054, 066.

563. (M E 563) **NONLINEAR FINITE ELEMENTS (3)** Advanced theory of semidiscrete formulations for continua and structures; emphasizes dynamic and nonlinear problems. Prerequisite: E MCH 461 or 560 or AG E 513.
565. **OPTIMAL DESIGN OF MECHANICAL AND STRUCTURAL SYSTEMS (3)** Application of numerical optimization techniques to design of mechanical and structural systems; design sensitivity analysis.
566. (E E) **ROBUST CONTROL (3)** Fundamentals of Robust Control Theory with emphasis on stability, performance analysis, and design. Prerequisite: E E 527 or M E 555.
577. (MATH) **STOCHASTIC SYSTEMS FOR SCIENCE AND ENGINEERING (3)** The course develops the theory of stochastic processes and linear and nonlinear stochastic differential equations for applications to science and engineering. Prerequisites: MATH 414 or 418; M E 550 or MATH 501.
596. **INDIVIDUAL STUDIES (1-9)**
597. **SPECIAL TOPICS (1-9)**

MEDIA STUDIES (MEDIA)

RICHARD L. BARTON, *Associate Dean for Graduate Studies*
 College of Communications
 201 Carnegie Building
 814-865-3070

Degree Conferred: M.A.

The Graduate Faculty

Richard L. Barton, Ph.D. (Oregon) *Associate Dean; Associate Professor of Communications;*
 Robert A. Baukus, Ph.D. (Massachusetts) *Associate Professor of Communications*
 R. Thomas Berner, M.A. (Penn State) *Professor of Journalism and American Studies*
 Ronald Bettig, Ph.D. (Illinois) *Assistant Professor of Communication*
 Barabara Bird, M.F.A. (Northwestern) *Assistant Professor of Communications*
 Clay Calvert, Ph.D. (Stanford) *Assistant Professor of Communications and Law*
 Jeremy Cohen, Ph.D. (Washington) *Interim Dean; Professor of Communications*
 Dennis K. Davis, Ph.D. (Minnesota) *Professor of Communications*
 Robert M. Frieden, J.D. (Virginia) *Professor of Communications*
 Katherine T. Frith, Ed.D. (Massachusetts) *Associate Professor of Advertising*
 Jeanne Hall, Ph.D. (Wisconsin) *Assistant Professor of Media Studies*
 M. Heather Hartley, M.F.A. (Ohio) *Assistant Professor of Communications*
 R. Dorn Hetzel, M.F.A. (New York) *Associate Professor of Film and Video*
 Anne Hoag, Ph.D. (Michigan) *Assistant Professor of Communications*
 Chris Jordan, Ph.D. (New Mexico) *Assistant Professor of Communications*
 Ann Marie Major, Ph.D. (Southern Illinois) *Assistant Professor of Communications*
 Mary S. Mander, Ph.D. (Illinois) *Associate Professor of Communications*
 Virginia Mansfield-Richardson, Ph.D. (Ohio) *Associate Professor of Communications*
 Charles A. McMellon, Ph.D. (CUNY) *Assistant Professor of Communications*
 Eve Stryker Munson, Ph.D. (Illinois) *Assistant Professor of Communications*
 John S. Nichols, Ph.D. (Minnesota) *Associate Professor of Communications*
 Anthony A. Olorunnisola, Ph.D. (Howard) *Assistant Professor of Communications*
 Patrick R. Parsons, Ph.D. (Minnesota) *Associate Professor of Communications*
 Daniel W. Pfaff, Ph.D. (Minnesota) *Professor of Journalism*
 Robert D. Richards, J.D. (American) *Associate Professor of Communications and Law*
 Ford Risley, Ph.D. (Florida) *Assistant Professor of Communications*
 Shari Roberts, Ph.D. (Chicago) *Assistant Professor of Communications*
 Jorge Reina Schement, Ph.D. (Stanford) *Professor of Communications*
 Shyam Sundar Sethuraman, Ph.D. (Standford) *Assistant Professor of Communications*
 E. Stratford Smith, M.L. (George Washington) *Cable TV Pioneer Chair Professor in Telecommunications Studies and Law*
 Susan M. Stroh, Ph.D. (Minnesota) *Assistant Professor of Communications*
 Richard D. Taylor, J.D. (New York) *Palmer Professor of Telecommunications Studies*
 W. Bradley Thompson, Ph.D. (Colorado) *Assistant Professor of Communications*

The master's degree in Media Studies is an academic program that involves students in the systematic study of media. The objective of the course of study is to enable students to achieve a comprehensive understanding of the systems, networks, cultures, and information associated with media. The program prepares students for doctoral study in communications and for professional positions in business and government requiring a comprehensive understanding of the historical, social, and political implications of the media. This program helps prepare students to organize research projects, critically evaluate research reports, and directly influence media practices by the application of research findings.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are required for admission. Students with a 3.00 junior/senior grade-point average are eligible for admission. Three letters of recommendation are required. Applicants must also submit an autobiographical statement of about 1,000 words indicating the nature of the applicant's interest in Media Studies, reasons for wanting to do graduate work, and future aspirations relating to the field of mass communications. Experience shows that most applicants hold a bachelor's degree in a field of the liberal arts or the social and behavioral sciences, including journalism and mass communications. However, this does not preclude applicants with other backgrounds, abilities, and interests such as those whose undergraduate training may have been in a scientific or technical field. In every case, the applicant should explain in the autobiographical statement how his or her undergraduate education relates to the decision to seek admission to graduate study in mass communications.

Program of Study

The M.A. program seeks to integrate two areas of inquiry and analysis. The "Critical Studies" area centers on the expressive, creative, and linguistic dimensions of media as cultural processes. The "Political Studies" area focuses primarily on the political and economic dimensions of national and international communications systems and processes. The student is encouraged to combine courses from these and possibly other areas into a coherent package of course work culminating in a thesis.

Degree Requirements

For the M.A. degree, candidates must complete a one-course research core by taking either COMM 506 (quantitative research methods) or COMM 511 (qualitative research methods). The remainder of the credits are selected by the student in consultation with the adviser from the graduate courses listed in this section. Candidates must complete a minimum of 36 credits, including 6 for the thesis (COMM 600). At least 18 credits must be at the 500 level. Course work offered by departments outside the College of Communications may be scheduled as part of the student's program with prior approval of the student's academic committee. In some cases, students may be required to take additional credits in order to make up deficiencies in undergraduate course work. Students are required to schedule three separate, formal meetings with their advisers and the academic committees for (1) discussion and approval of the general program plan, (2) the thesis proposal and (3) the defense of the thesis. In most cases, satisfactory completion of course work and thesis requires two years.

Student Aid

Graduate assistantships and other forms of student aid available to students in this program are described in the STUDENT AID section of the *Graduate Bulletin*.

COMMUNICATIONS (COMM)

- 401. MASS MEDIA IN HISTORY (3)
- 403. LAW OF MASS COMMUNICATIONS (3)
- 404. MASS COMMUNICATIONS RESEARCH (3)
- 405. POLITICAL ECONOMY OF COMMUNICATIONS (3)
- 407. (ECON) ADVERTISING IN THE AMERICAN ECONOMY (3)
- 408. (S T S) CULTURAL FOUNDATIONS OF COMMUNICATION (3)
- 409. NEWS MEDIA ETHICS (3)
- 410. INTERNATIONAL MASS COMMUNICATIONS (3)
- 411. CULTURAL ASPECTS OF THE MASS MEDIA (3)
- 413. THE MASS MEDIA AND THE PUBLIC (3)
- 417. ADVERTISING REGULATION AND ETHICS (3)
- 419. WORLD MEDIA SYSTEMS (3)
- 421W. ADVERTISING COMMUNICATIONS PROBLEMS (3)
- 422. ADVERTISING MEDIA PLANNING (3)

424. ADVERTISING CAMPAIGNS (3)
425. ADVERTISING MESSAGE STRATEGY (3)
430. ADVANCED NONFICTION WRITING WORKSHOP (3 per semester, maximum of 6)
437. NARRATIVE VIDEO/FILMMAKING (3)
438. NONFICTION VIDEO/FILMMAKING (3)
439. ALTERNATIVE FILM/VIDEO PRODUCTION (3)
440. ADVANCED PRODUCTION TECHNOLOGY AND TECHNIQUE (3)
442. ADVANCED FILM AND VIDEO PRODUCTION I (6)
443. ADVANCED FILM AND VIDEO PRODUCTION II (6)
445. DIRECTING FOR THE SCREEN II (3)
446. WRITING FOR THE SCREEN II (3)
447. FILM AND VIDEO ANIMATION (3)
448. ADVANCED CINEMATOGRAPHY AND SOUND WORKSHOP (3)
450. ANALYSIS OF FILM PRACTICE (3)
451. TOPICS IN AMERICAN FILM (3 per semester, maximum of 6)
452. TOPICS IN INTERNATIONAL CINEMA (3 per semester, maximum of 6)
453. (CMLIT) NARRATIVE THEORY: FILM AND LITERATURE (3)
454. DOCUMENTARY IN FILM AND TELEVISION (3 per semester, maximum of 6)
455. ADVANCED FILM THEORY AND CRITICISM (3 per semester, maximum of 6)
- 460W. REPORTING METHODS (3)
461. PROFESSIONAL JOURNALISM SEMINAR (3 per semester, maximum of 6)
462. THE FEATURE ARTICLE (3)
463. SCIENCE JOURNALISM (3 per semester, maximum of 6)
464. EDITORIAL WRITING AND NEWS ANALYSIS (3)
465. BROADCAST JOURNALISM II (3)
466. PUBLIC AFFAIRS BROADCASTING (3)
467. NEWS EDITING AND EVALUATION (3)
468. GRAPHIC APPLICATIONS IN PRINT COMMUNICATIONS (3)
469. PHOTOGRAPHY FOR THE MASS MEDIA (3)
471. PUBLIC RELATIONS MEDIA AND METHODS (3)
473. PUBLIC RELATIONS PROBLEMS (3)
480. THEORIES AND ISSUES IN MASS COMMUNICATIONS (3)
481. TELEVISION PRODUCTION AND PERFORMANCE (3)
482. ADVANCED RADIO PRODUCTION (3)
483. TELECOMMUNICATIONS REGULATION (3)
484. EMERGING TELECOMMUNICATIONS TECHNOLOGIES (3)
485. ANALYSIS OF BROADCAST-CABLE POLICY (3)
486. CORPORATE AND NONBROADCAST VIDEO (3)
487. TELEVISION AND RADIO ADMINISTRATION (3)
488. CABLE AND NEW TECHNOLOGIES ADMINISTRATION (3)
494. RESEARCH TOPIC (1–12)
495. INTERNSHIP (1–3)
496. INDEPENDENT STUDIES (1–18)
497. SPECIAL TOPICS (1–9)
499. FOREIGN STUDY—MASS COMMUNICATIONS (1–12)
- 501.1, 501.2. PROSEMINAR IN MASS COMMUNICATIONS (3) Overview of paradigms in mass communications research.
504. SEMINAR IN THE HISTORY OF MASS COMMUNICATIONS (3)
505. INTERNATIONAL COMMUNICATION PROBLEMS (3) Legal and communications problems of the international flow of news and opinion; international press codes.
506. INTRODUCTION TO MASS COMMUNICATIONS RESEARCH (3) The scientific method; survey of basic concepts of theoretical and empirical research; variety of methodology; criteria for adequate research.
507. NEWS MEDIA AND PUBLIC OPINION (3) Problems in the function, techniques, and responsibilities of press, radio, and television in forming and interpreting opinion.
508. THE LITERATURE OF JOURNALISM (3) The intersection of journalism and literature is explored via the nonfiction writing of various authors, mostly, but not exclusively, American.
509. JOURNALISM ETHICS (3) Evolving ethics, standards, and social responsibility in American journalism; business nature of news media; case studies.

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510. COMPARATIVE THEORIES OF PRESS SYSTEMS (3) Institutional structure and normative functions of press systems in modern societies, as shaped by prevailing world view and social organization.
511. MASS COMMUNICATIONS RESEARCH METHODS II (3) Problems of research; evaluation of sources and materials in mass communications history, biography, structure, ethics, and other areas.
512. GOVERNMENT AND MASS COMMUNICATIONS (3) Problems of freedom of information; governmental efforts to control mass communications agencies; government news coverage; public information agencies.
513. CONSTITUTIONAL PROBLEMS OF THE NEWS MEDIA (3) Problems involving conflict between guarantees of press freedom in the First and Fourteenth Amendments and rights and privileges of others.
520. SEMINAR IN ADVERTISING PROBLEMS (3) Close examination of current issues and problems in national and international advertising.
521. ADVERTISING PERSPECTIVES (3) An overview of advertising in industrial societies including institutional issues; sociodemographic issues; public policy issues; and ethical issues.
522. ADVERTISING AND CULTURE (3) Advertising as culture; retheorizing advertising from a cultural/literary perspective; semiotic and hermeneutic analysis; advertising as social communication.
550. FILM THEORY AND CRITICISM (3) Studies in traditional and contemporary film theory and criticism. Prerequisite: COMM 455.
553. SPECIAL TOPICS IN FILM AND TELEVISION (1-3) Advanced studies in current theoretical paradigms in film and television studies.
556. TEXTUAL ANALYSIS (3) Using theoretically informed, close textual analysis approach, course will explore the way films and videos generate meaning.
580. SEMINAR IN TELECOMMUNICATIONS (3) Study of the historical and contemporary issues and problems in telecommunications.
581. HISTORY OF ELECTRICAL, ELECTRONIC, AND OPTICAL COMMUNICATIONS (3) Study of the historical development of the telecommunications industries.
582. ETHICS AND EMERGING COMMUNICATIONS TECHNOLOGY (3) Identification and analysis of ethical issues raised by electronic communications technologies. Prerequisites: COMM 483, 484, 581.
583. SEMINAR ON U.S. TELECOMMUNICATIONS POLICY (3) Examination of the U.S. telecommunications policy process and current issues. Prerequisites: COMM 483, 484, 581.
590. COLLOQUIUM (1-3) Continuing seminars which consist of a series of individual lectures by faculty, students, or outside speakers.
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

METEOROLOGY (METEO)

DENNIS W. THOMSON, *Head of the Department*
503 Walker Building
814-865-0478

Degrees Conferred: Ph.D., M.S.

The Graduate Faculty

Thomas P. Ackerman, Ph.D. (Washington) *Professor of Meteorology*
Peter R. Bannon, Ph.D. (Colorado) *Professor of Meteorology*
Alfred K. Blackadar, Ph.D. (NYU) *Professor Emeritus of Meteorology*
Craig H. Bishop, Ph.D. (Monash) *Assistant Professor of Meteorology*
Craig F. Bohren, Ph.D. (Arizona) *Distinguished Professor of Meteorology*
William H. Brune, Ph.D. (Johns Hopkins) *Professor of Meteorology*
John J. Cahir, Ph.D. (Penn State) *Professor of Meteorology*
Toby N. Carlson, Ph.D. (Imperial College-London) *Professor of Meteorology*
John H. E. Clark, Ph.D. (Florida State) *Associate Professor of Meteorology*
Eugene Clothiaux, Ph.D. (Brown) *Research Associate in Meteorology*
Rosa G. de Pena, Ph.D. (Buenos Aires) *Professor Emerita of Meteorology*
John A. Dutton, Ph.D. (Wisconsin) *Professor of Meteorology*
Jenni L. Evans, Ph.D. (Monash) *Associate Professor of Meteorology*
Gregory S. Forbes, Ph.D. (Chicago) *Associate Professor of Meteorology*
William M. Frank, Ph.D. (Colorado State) *Professor of Meteorology*

Alistair B. Fraser, Ph.D. (Imperial College-London) *Professor of Meteorology*
 J. Michael Fritsch, Ph.D. (Colorado State) *Professor of Meteorology*
 Charles L. Hosler, Ph.D. (Penn State) *Professor Emeritus of Meteorology*
 Gregory S. Jenkins, Ph.D. (Michigan) *Assistant Professor of Meteorology*
 James F. Kasting, Ph.D. (Michigan) *Professor of Geosciences and Meteorology*
 Dennis Lamb, Ph.D. (Washington) *Professor of Meteorology*
 Sukyoung Lee, Ph.D. (Princeton) *Assistant Professor of Meteorology*
 Raymond G. Najjar, Ph.D. (Princeton) *Assistant Professor of Meteorology*
 Nelson L. Seaman, Ph.D. (Penn State) *Assistant Professor of Meteorology*
 Hampton N. Shirer, Ph.D. (Penn State) *Associate Professor of Meteorology*
 Todd A. Sowers, Ph.D. (Rhode Island) *Assistant Professor of Geosciences and Meteorology*
 John L. Spiesberger, Ph.D. (Scripps Inst. of Oceanography) *Associate Professor of Meteorology*
 David R. Stauffer, Ph.D. (Penn State) *Research Associate of Meteorology*
 Dennis W. Thomson, Ph.D. (Wisconsin) *Professor of Meteorology*
 Johannes Verlinde, Ph.D. (Colorado State) *Assistant Professor of Meteorology*
 John C. Wyngaard, Ph.D. (Penn State) *Professor of Meteorology and GeoEnvironmental/Mechanical Engineering*
 George S. Young, Ph.D. (Colorado State) *Associate Professor of Meteorology and GeoEnvironmental Engineering*

The graduate program embraces topics that span atmospheric processes from those of the planetary boundary layer to those of the upper atmosphere, that encompass phenomena with molecular to planetary dimensions, and that range from practical to theoretical significance. The program develops and integrates approaches based on observational, computational and analytical techniques.

The major interests of the faculty and graduate students center on (1) analysis, modeling, and prediction of the evolution of synoptic scale and mesoscale weather systems, particularly those of significant impact on human activities; (2) observation and theoretical study of processes related to transmission of radiation through the atmosphere, including remote sensing through use of electromagnetic or acoustic systems; (3) theoretical study of atmospheric dynamics on a variety of scales, including phenomena of weather and climate, boundary layer physics, turbulence, and convective systems.

The department encourages interdisciplinary studies and is expanding its programs in biometeorology, climate dynamics, environmental quality, development of microwave and acoustical sensors, atmospheric trace chemistry, boundary layer processes, forecast reliability, mathematical study of fluid dynamical systems, and integrated atmosphere-ocean studies.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are required for the evaluation of all applicants. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Other requirements for admission include mathematics through differential equations and one year of college physics. Undergraduate study of meteorology is not required for admission. Special programs are available to encourage the graduate study of meteorology by all students with strong backgrounds in mathematics, physics, or engineering. Students with a 3.00 junior/senior grade-point average (on a 4.00 scale) and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students.

Doctoral Degree Requirements

Studies for the Ph.D. degree are designed to accommodate the interests and capabilities of the candidate by a doctoral committee, which also administers comprehensive and final oral examinations. Before being admitted to Ph.D. candidacy, a student must have the academic support of a faculty member and the student must pass each part of the three-part Ph.D. candidacy exam that is normally offered twice each year. In order to assess the student's progress in assimilating the required material, all three sections of the exam must be taken within one year of being admitted to the program and the student must pass the entire exam within two years of admission. Once a student passes a section of the candidacy exam, the student does not take that section again. Before being admitted to the comprehensive exam, a student must have passed the department's competency exam in written and spoken technical English. Before being admitted to the final oral exam, a student must have completed 15 required credits: METEO 541, 9 electives in 400- or 500-level courses outside the department that are related to the student's area of study, and 3 credits from at least two different graduate seminar courses within the department. The student is expected to master

METEOROLOGY

the material in the M.S. core courses (METEO 520, 521, 533, and 535), but need not take those courses for credit.

Master's Degree Requirements

The Master of Science degree program comprises instructional and research components. A 12-credit core curriculum is required that is composed of METEO 520, 521, 533, and 535. At least 12 additional credits must be taken in 400- and 500-level course work, and at least 6 of those credits must be taken in 500-level meteorology lecture courses. The degree is offered with both thesis and research paper options; those students who are writing a thesis will take 6 credits of METEO 600 and those who write a paper will take an additional 6 credits of 500-level course work.

Proficiency in the fundamental concepts of dynamic and physical meteorology is demonstrated by a student passing each part of the three-part M.S. comprehensive exam that is normally offered twice each year. In order to assess the student's progress in assimilating the required material, all three sections of the exam must be taken the first time the exam is offered after the student has completed the four core courses. Normally the unpassed sections of the exam must be taken each time the exam is offered until all three sections have been passed; a student may take each section a maximum of three times. The exam also serves as the Ph.D. Candidacy Exam: A student who passes all three parts at the Ph.D. level and has the adviser's academic support will qualify for Ph.D. candidacy.

Other Relevant Information

The program differentiates between instruction and research topics appropriate for M.S. students seeking positions of advanced responsibility in government or industry, those appropriate for M.S. students anticipating further study, and those appropriate for Ph.D. candidates who will work in advanced research laboratories or academic institutions.

Student Aid

Graduate assistantships available through this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*. Most graduate students are supported with teaching or research assistantships.

METEOROLOGY (METEO)

- 411. SYNOPTIC METEOROLOGY LABORATORY (4)
- 412. SYNOPTIC APPLICATIONS OF DYNAMIC METEOROLOGY (4)
- 414. MESOSCALE METEOROLOGY (3)
- 415. FORECASTING PRACTICUM (3)
- 416. ADVANCED FORECASTING (3)
- 417. HYDROMETEOROLOGY (3)
- 481W. TOPICS IN MESOSCALE METEOROLOGY (4)
- 421. DYNAMIC METEOROLOGY I (4)
- 422. DYNAMIC METEOROLOGY II (4)
- 431. ATMOSPHERIC THERMODYNAMICS (3)
- 436. ATMOSPHERIC PHYSICS I (3)
- 437. ATMOSPHERIC PHYSICS II (3)
- 445. LABORATORY IN ATMOSPHERIC PHYSICS I (1)
- 446. LABORATORY IN ATMOSPHERIC PHYSICS II (1)
- 451. ELEMENTS OF PHYSICAL OCEANOGRAPHY (3)
- 452. TROPICAL METEOROLOGY (3)
- 454. INTRODUCTION TO MICROMETEOROLOGY (3)
- 455. ATMOSPHERIC DISPERSION (3)
- 456. ENVIRONMENTAL METEOROLOGY (3)
- 465. MIDDLE ATMOSPHERE METEOROLOGY (3)
- 466. PLANETARY ATMOSPHERES (3)
- 471W. OBSERVING METEOROLOGICAL PHENOMENA (3)
- 472. TOPICS IN CLIMATOLOGY (3)
- 473. APPLICATIONS OF COMPUTERS TO METEOROLOGY (3)
- 474. APPLICATIONS OF STATISTICS TO METEOROLOGY (3)
- 480W. UNDERGRADUATE RESEARCH (3)
- 491. JOINT NATIONAL WEATHER SERVICE MAP DISCUSSION (1)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

501. **ATMOSPHERIC PHENOMENA** (3) Overview of the complex interactions within the atmosphere, ranging from molecular to global scale.
512. **ADVANCED SYNOPTIC APPLICATIONS OF DYNAMIC METEOROLOGY** (4) Graduate version of topics covered in METEO 412. Prerequisites: METEO 411 or 411H; METEO 422.
514. **MESOSCALE WEATHER PHENOMENA** (3) Historical and current case examples are utilized as vehicles to explore the structure and dynamics of mesoscale weather phenomena. Prerequisites: METEO 411, 521.
516. **MESOSCALE FORECASTING** (3) Competitive, simulated, operational, real-time forecasting is covered. Prerequisites: METEO 414 or 514; METEO 415.
520. **GEOPHYSICAL FLUID DYNAMICS** (3) An introduction to the mathematical description and modeling of atmospheric and oceanic motions.
521. **DYNAMIC METEOROLOGY** (3) An overview of the major large-scale atmospheric motions of weather and climate. Prerequisite: METEO 520.
523. **MODELING THE CLIMATE SYSTEM** (3) The mathematical and physical assumptions underlying global modeling, available climate data, model validation, and current climate research controversies. Prerequisite or concurrent: METEO 541.
526. **NUMERICAL WEATHER PREDICTION** (3) Finite difference and spectral methods, barotropic and baroclinic models, filtered and primitive equation models, synoptic-scale and mesoscale models. Prerequisite: METEO 422.
527. **ATMOSPHERIC WAVE MOTION** (3) Fundamental processes for acoustic, gravity, inertial, and Rossby waves in the atmosphere and ocean. Prerequisite: METEO 520.
528. **LARGE-SCALE DYNAMICS** (3) Selected topics of current interest in large-scale atmospheric dynamics. Prerequisite: METEO 521.
529. **MESOSCALE DYNAMICS** (3) A survey of concepts of mesoscale systems, including frontogenesis, symmetric instability, mountain waves, wave CISK, and frontal waves. Prerequisite: METEO 521.
532. **CHEMISTRY OF THE ATMOSPHERE** (3) Review of chemical principles in gaseous and multiphase environments; characteristics of key atmospheric components and chemical systems in the lower and middle atmosphere. Prerequisite: CHEM 012.
533. **CLOUD PHYSICS** (3) Overview of cloud systems; theories of phase changes in clouds and microphysical mechanism of precipitation formation; cloud electrification. Prerequisite: METEO 431 or equivalent.
534. **CLOUD DYNAMICS** (3) Study of the air motions within clouds, as they interact with the microphysical processes. Prerequisites: METEO 521, 533.
535. **RADIATIVE TRANSFER** (3) Fundamentals of electromagnetic radiation and its interaction with matter; radiation and climate, atmospheric remote sensing, and observable atmospheric optical phenomena.
537. **RADAR METEOROLOGY** (3) Weather radar principles; single- and dual-Doppler radar analysis techniques; multiparameter (dual polarization, dual wavelength) radar analysis; introduction to NEXRAD. Prerequisites: METEO 421, PHYS 204.
538. **ATMOSPHERIC CONVECTION** (3) Properties of shallow and deep atmospheric convection and interactions between convection, the boundary layer, and larger-scale weather systems.
541. **THE EARTH SYSTEM** (3) The dynamical and physical aspects of the interacting subsystems within the Earth system. Prerequisites: METEO 521, 533, 535.
551. **DYNAMIC OCEANOGRAPHY** (2) Physical properties of sea water; heat balance of the oceans; theory and observations of ocean currents, waves, and tides.
554. **ATMOSPHERIC TURBULENCE** (3) An introduction to the physics, structure, modeling, representation, and measurement of atmospheric turbulence. Prerequisite: METEO 520.
555. **ATMOSPHERIC DIFFUSION** (3) The theory of molecular and turbulent diffusion; experiments, theory, and practical implications of air pollution problems. Prerequisite: METEO 520.
556. **PLANETARY BOUNDARY LAYER MODELING** (3) The essential physics of the planetary boundary layer and its simplified representation in atmospheric models on local to global scales. Prerequisites: AERSP 524, ME 524, or METEO 554.
563. **BIOCLIMATOLOGY** (3) Interaction between humans, animals, and plants and their environment. Theoretical basis for various comfort indices and water stress in plants.
565. **PHYSICS OF THE UPPER ATMOSPHERE** (3) Graduate version of material that is covered in METEO 465. Prerequisites: METEO 421, 431.
570. **NONLINEAR DYNAMICS SEMINAR** (1–3 per semester, maximum of 15) Review of mathematical techniques used in nonlinear hydrodynamic studies; topics vary each semester but include ongoing departmental research.

574. **ATMOSPHERIC DYNAMICS SEMINAR** (1–3 per semester, maximum of 15) A weekly seminar course that focuses on current and past research problems in dynamic meteorology and oceanography.
575. **CLIMATE DYNAMICS SEMINAR** (1–3 per semester, maximum of 15) Review of evolving climate dynamics and Earth system science, including ongoing departmental research.
577. **CONVECTIVE BOUNDARY LAYER** (1–3 per semester, maximum of 15) Seminar treatment of theory, observation, and modeling of mean and turbulent structures; cloud processes and radiation; air-sea interactions.
579. **ADVANCES IN FORECASTING TECHNIQUES SEMINAR** (1–3 per semester, maximum of 15) Review of recent advances in weather forecasting techniques; topics vary each semester to cover the full spectrum of forecast problems.
580. **COMMUNICATION OF METEOROLOGICAL RESEARCH** (1 per semester, maximum of 10) Methods for effective written and oral presentation of meteorological research are reviewed.
581. **TOPICS IN ATMOSPHERIC CHEMISTRY** (1–3 per semester, maximum of 15) Discussion of recent research papers in, and concepts pertinent to, acidic deposition, photochemical air pollution, and global chemical budgets.
582. **ICE AND SNOW PHYSICS** (1–3 per semester, maximum of 15) Structure of ice and its electrical, optical, mechanical, and surface properties; snow formation in the atmosphere.
584. **MIDDLE ATMOSPHERE RESEARCH** (1–3 per semester, maximum of 15) A graduate seminar discussing current topics in middle atmospheric research, including measurements, modeling, dynamics, environmental issues, and solar-terrestrial relations.
586. **ADVANCES IN NUMERICAL WEATHER PREDICTION** (1–3 per semester, maximum of 15) Recent advances in numerical weather prediction will be discussed by faculty and students. Prerequisite: METEO 526.
587. **TOPICS IN ATMOSPHERIC PHYSICS** (1–3 per semester, maximum of 15) Seminar discussion of physical processes in the atmosphere including cloud life cycles, radiative transfer, remote sensing, and hydrologic cycle.
588. **(GEOSC) OCEANS AND CLIMATE SEMINAR** (2) A focused discussion on some aspect of the ocean's role in the climate system. Theme to vary from semester to semester.
590. **COLLOQUIUM** (1)
591. **MAP DISCUSSION WITH THE NATIONAL WEATHER SERVICE** (1) Students evaluate and discuss real-time, regional, and local weather conditions and forecasts with University instructors and National Weather Service forecasters. Prerequisites: METEO 411, 415. Concurrent: METEO 414.
596. **INDIVIDUAL STUDIES** (1–9)
597. **SPECIAL TOPICS** (1–9)

NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in meteorological studies are listed under MATERIALS SCIENCE.

MICROBIOLOGY AND IMMUNOLOGY (MICRO)

RICHARD J. COURTNEY, *Chair of the Department*
The Milton S. Hershey Medical Center
Hershey, PA 17033
717-531-6521

Degrees Conferred: Ph.D., M.S.

The Graduate Faculty

Robert H. Bonneau, Ph.D. (Penn State) *Assistant Professor of Microbiology and Immunology*
Michael J. Chorney, Ph.D. (Cornell) *Associate Professor of Microbiology and Immunology and Pediatrics*
Neil D. Christensen, Ph.D. (Auckland, New Zealand) *Assistant Professor of Pathology, Microbiology and Immunology*
Richard J. Courtney, Ph.D. (Syracuse) *Professor of Microbiology and Immunology*
Rebecca C. Craven, Ph.D. (Tennessee) *Assistant Professor of Microbiology and Immunology*
John N. Goldman, M.D. (Cincinnati) *Professor of Medicine and Microbiology and Immunology*
Margaret B. Goldman, Ph.D. (Boston) *Associate Professor of Medicine and Microbiology and Immunology*
Mary K. Howett, Ph.D. (Pennsylvania) *Professor of Microbiology and Immunology*

Harriet C. Isom, Ph.D. (Illinois) *Professor of Microbiology, Immunology, and Pathology*
 Sebastian Joyce, Ph.D. (Med. Coll. of Virginia) *Assistant Professor of Microbiology and Immunology*
 Michael Katzman, M.D. (Columbia) *Assistant Professor of Medicine and Microbiology and Immunology*
 Craig Meyers, Ph.D. (UCLA) *Assistant Professor of Microbiology and Immunology*
 Leslie J. Parent, M.D. (Duke) *Assistant Professor of Medicine, and Microbiology and Immunology*
 David J. Spector, Ph.D. (Pennsylvania) *Associate Professor of Microbiology and Immunology*
 Shao-Cong Sun, Ph.D. (Stockholm, Sweden) *Assistant Professor of Microbiology and Immunology*
 Richard B. Tenser, M.D. (SUNY-Upstate) *Professor of Medicine and Microbiology and Immunology*
 M. Judith Tevethia, Ph.D. (Michigan State) *Professor of Microbiology and Immunology*
 Satvir S. Tevethia, B.V.Sc. (Agra, India); Ph.D. (Michigan State) *Distinguished Professor of Microbiology and Immunology*
 Michael F. Verderame, Ph.D. (Columbia) *Assistant Professor of Medicine, Microbiology and Immunology*
 Brian Wigdahl, Ph.D. (Medical College of Wisconsin) *Professor of Microbiology and Immunology*
 John W. Wills, Ph.D. (Tennessee) *Professor of Microbiology and Immunology*

The graduate program in Microbiology and Immunology emphasizes basic research consisting of the application of molecular, genetic, and biochemical approaches to problems of fundamental biological interest. The research activities of the department are focused on the study of the interactions of viruses with their host cells and organisms with emphasis on adenoviruses, hepatitis virus, herpesviruses, papillomaviruses, papovaviruses, and retroviruses. Individual research programs center on virus replication and cellular immune response in these processes. Viral systems are also utilized as models for the study of eukaryotic gene regulation, protein transport and processing, transmembrane and intracellular signal transduction, and the human immune response. In addition, active research programs are maintained in the areas of eukaryotic cellular differentiation and growth control, tumor cell biology and immunology, and the mapping of human immune response genes and genes associated with other human diseases.

A laboratory rotation program during the first academic year serves as an introduction to the different subdisciplines and investigators. This experience acquaints each student with four research groups leading to the choice of a permanent research adviser. A broad-based curriculum and stimulating series of seminars and literature reports complement the research training.

Admission Requirements

Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by the Graduate Program Committee and authorized by the dean of the Graduate School, are required for admission. Requirements listed here are in addition to general Graduate School admission requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.

Qualified students with undergraduate preparation in biological, biochemical, or physical sciences may apply. An adequate background in biology, general and organic chemistry, and mathematics and an overall grade-point average of 3.00 or better are required.

The best-qualified applicants will be accepted on a space-available basis. Formal applications should contain three letters of recommendation and a brief personal essay summarizing the background and professional goals of the applicant.

Degree Requirements

A specified core curriculum includes the following courses: BCHEM 502, 520, CMBIO 501, 540, MICRO (BCHEM, CMBIO) 503, MICRO 550, 551, 552, 572, and 596, as well as courses in molecular genetics, featured special topics (immunology), biostatistics, and ethics. To augment the core sequence of courses, students and their research committees will formulate an individualized advanced curriculum involving departmental courses in virology, immunology, and tumor cell biology, as well as graduate courses offered by other departments.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

MICROBIOLOGY AND IMMUNOLOGY (MICRO)

503. (BCHEM, CMBIO) MOLECULAR BIOLOGY (3) Principles of molecular and microbial genetics; emphasis placed on experimental design toward problems in bacteria and lower eukaryotes. Prerequisite: BCHEM 502.

MINERAL ENGINEERING MANAGEMENT

550. MEDICAL MICROBIOLOGY (3) Principles of medical microbiology: host-parasite relationships; structure and function of viruses, bacteria, and fungi as agents causing human disease.
551. MEDICAL MICROBIOLOGY (3) Principles of medical microbiology: host-parasite relationships; structure and function of viruses, bacteria, and fungi as agents causing human disease. Prerequisite: MICRO 550.
552. MEDICAL MICROBIOLOGY LABORATORY (1) Laboratory exercises to augment MICRO 551. Laboratory tests used to characterize microorganisms and to aid in diagnosis of disease. Concurrent: MICRO 551.
553. (CMBIO) SCIENCE OF VIROLOGY (3) Replication of viruses and effect on host, including transfer of genetic information, immunology, and oncogenic properties of viruses. Prerequisite: MICRO 503.
554. PRINCIPLES OF IMMUNOLOGY (2) Study of immune response. Nature of antigens, structure, function of antibodies, hypersensitivity, transplantation and tumor immunology, autoimmunity, and immunosuppression.
560. (CMBIO) CONCEPTS IN IMMUNOLOGY (3) Lectures in advanced immunology, including T and B cell function, receptors, gene rearrangements, and synthetic vaccines.
561. MOLECULAR BIOLOGY OF CELLULAR GROWTH CONTROL (2) Advanced course using primary literature to explore molecular mechanisms of regulated cell growth and loss of regulation in oncogenesis. Prerequisite: MICRO 503.
572. LITERATURE REPORTS (1 per semester) Weekly analysis of current literature in microbiology.
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

MINERAL ENGINEERING MANAGEMENT (M E M)

R. V. RAMANI, *In charge of Graduate Program in Mineral Engineering Management*
126A Hosler Building
814-863-1621

Degree Conferred: M.Eng.

The Graduate Faculty

Michael Adewumi, Ph.D. (Illinois) *Professor of Petroleum and Natural Gas Engineering*
Frank F. Aplan, Sc.D. (MIT) *Professor Emeritus of Metallurgy and Mineral Processing*
Christopher J. Bise, Ph.D. (Penn State) *Professor of Mining Engineering*
M. Jeya Chandra, Ph.D. (Syracuse) *Associate Professor of Industrial Engineering*
Turgay Ertekin, Ph.D. (Penn State) *Professor of Petroleum and Natural Gas Engineering*
Robert L. Frantz, M.S. (Penn State) *Professor Emeritus of Mining Engineering*
Abraham S. Grader, Ph.D. (Stanford) *Associate Professor of Petroleum and Natural Gas Engineering*
Peter T. Luckie, Ph.D. (Penn State) *Professor of Mineral Engineering*
Jan M. Mutmanský, Ph.D. (Penn State) *Professor of Mining Engineering*
L. Barry Phelps, Ph.D. (Penn State) *Associate Professor Emeritus of Mining Engineering*
Raja V. Ramani, Ph.D. (Penn State) P.E. *Professor of Mining Engineering*
Gerald I. Susman, Ph.D. (UCLA) *Professor of Organizational Behavior*
Robert W. Watson, Ph.D. (Penn State) *Associate Professor of Petroleum and Natural Gas Engineering*
Harry H. West, Ph.D. (Illinois) P.E. *Professor Emeritus of Civil Engineering*
Jack H. Willenbrock, Ph.D. (Penn State) P.E. *Professor Emeritus of Civil Engineering*

This program is designed to educate engineers for advancement into executive production management positions in the mineral and heavy construction industries, in development and sales in manufacturing companies, and in consulting firms. Its aim is to provide the knowledge, skills, and attitudes needed by persons to become innovators and responsible decision-making leaders. Participants are trained to create new designs, systems, and methods, and to plan, develop, and lead mineral industry organizations.

The content of appropriate courses is based upon specific problems encountered in the mineral industries. Such courses are offered by the departments that have combined their resources to offer this interdisciplinary effort: the Departments of Mineral Engineering (Mining and Petroleum and Natural Gas sections), Mineral Economics, Materials Science and Engineering, and Industrial and Management Systems Engineering. Courses in these areas and others and may be selected by students and adapted to their individual interests.

The program emphasizes quantitative methods, principles of economics applied in mineral industries, and management.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are not required for admission. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

For admission a bachelor's degree in one of six engineering branches of mineral industry (mining, petroleum, mineral processing, metallurgy, fuel, or ceramics) or some other closely related field (industrial, civil, geological, mechanical, or chemical engineering) is required. Students with a 2.50 junior/senior grade-point average (on a 4.00 scale) and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special background, abilities, and interests.

Degree Requirements

Students are required to present a scholarly written report on a suitable project, the topic of which may be suggested by industry. The report must be approved by a committee of the faculty comprised of report adviser, report reader, and chair of the program. Each student also is required to take 1 credit of colloquium and present a satisfactory seminar on some topic, including the report topic.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

MINERAL ENGINEERING MANAGEMENT (M E M)

510. PRODUCTION AND OPERATIONS MANAGEMENT (3–9) Overall planning, design, and selection of equipment; programming and scheduling of mineral operations; statistical control of costs and production indices.

598. SPECIAL TOPICS (1–9)

599. FOREIGN STUDIES (1–12 per semester, maximum of 24)

MINERAL PROCESSING (MN PR)

SUBHASH CHANDER, *In Charge of Graduate Programs in Mineral Processing*
123 Hosler Building
814-863-1640

Degrees Conferred: Ph.D., M.S.

The Graduate Faculty

Frank Aplan, Sc.D. (MIT) *Distinguished Professor Emeritus of Metallurgy and Mineral Processing*
Leonard G. Austin, Ph.D. (Penn State) *Professor Emeritus of Fuels and Mineral Engineering*
S. Chander, Ph.D. (California, Berkeley) *Professor of Mineral Processing*
Richard Hogg, Ph.D. (California, Berkeley) *Professor of Mineral Processing*
M. Thaddeus Ityokumbul, Ph.D. (Univ. of Western Ontario) *Assistant Professor of Mineral Processing*
Mark S. Klima, Ph.D. (Penn State) *Associate Professor of Mineral Processing*
Peter T. Luckie, Ph.D. (Penn State) *Professor of Mineral Engineering*
K. Osseo-Asare, Ph.D. (California, Berkeley) *Professor of Metallurgy*

This program is one of the options in which a graduate student in the Department of Mineral Engineering can receive an advanced degree. Mineral processing is concerned with the extraction and purification of valuable commodities from the earth. The raw materials produced by mining are highly impure and must be upgraded before they are of use to society. For example, the cleaning of coal to minimize pollution is an area of national and international concern. Energy, raw materials, and the environment are some of the most serious problem areas facing the world today. Mineral processing engineers play a key role in reducing and solving these problems.

The refining of mineral commodities involves a broad variety of problems, mostly associated with the production, handling, and separation of solid particles. Particle systems are also critical to many of the

processes and products of modern industry: materials, chemicals, and electronics as well as minerals. Mineral processing engineers are at the forefront of the development of the science and technology of particle systems, and many of the techniques and procedures used in mineral processing find direct application in other areas. Training of a mineral-processing engineer involves interdisciplinary study of chemistry, physics, the geological sciences, and engineering with special emphasis on concentration by physical methods; surface chemistry of particles; particle processing; chemical and thermal extraction processes, etc.

Pollution control and the preservation of environmental quality are of major concern to the mineral processing profession. The mining and processing industries produce large quantities of solid waste which must be disposed of properly. Process water must be treated for reuse or disposal and processing systems must be designed and operated so as to minimize air pollution. At the same time, many air and water pollution control methods use equipment and processes originally developed for the mineral industries. Mineral processing methods are also involved in the recovery, recycling, and reuse of metals and other materials. The Mineral Processing faculty also participate in the all-University interdisciplinary program leading to the Master of Science in environmental pollution or the Master of Environmental Pollution Control degrees.

Admission Requirements

Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by the graduate program, are required for admission. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Graduates with bachelor's degrees in an engineering or science discipline are normally eligible for admission. Students with deficiencies may be required to take a modest amount of remedial work concurrently with their graduate studies. Students with a 2.50 junior/senior grade-point average (on a 4.00 scale) and with appropriate course backgrounds will be considered for admission. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds (such as industrial experience), abilities, and interests.

Master's Degree Requirements

Students will be expected to demonstrate competence in areas outside of the major field and may be required to take courses in other fields. A research thesis is required of all M.S. students and must be defended orally before a committee of the faculty. Every student also will be expected to present a satisfactory seminar on the results of his or her research.

Doctoral Degree Requirements

The communication and foreign language requirement for the Ph.D. degree may be satisfied by reading proficiency in one foreign language. Students whose first language is English must demonstrate proficiency in German, Russian, or Japanese (or other language in which a major body of relevant technical literature exists). Students whose first language is not English will be required to show fluency in reading, speaking, comprehending, and writing English and may in some cases be required to demonstrate proficiency in one other approved language.

No set number of credits is required, but a student normally would be expected to take a minimum of 15 credits of course work beyond the M.S. degree. Ph.D. candidates will be expected to demonstrate competence in the areas of (1) general mineral processing, (2) applied surface chemistry, (3) particle technology, (4) chemical processes, process metallurgy, and thermodynamics.

A minor field is not required. However, Ph.D. candidates will be expected to take at least 12 credits outside of the major. These courses need not be in a single field but should consist of a coherent group with some unifying theme.

Admission to candidacy is by examination (written and/or oral) and normally includes a satisfactory written paper consisting of a definition of the student's research problem and a critical evaluation of the relevant literature or a coherent critical review of the literature on some appropriate topic. In some cases, the Penn State M.S. thesis defense in mineral processing may be used to satisfy some or all of these requirements.

The comprehensive examination consists of two parts: (1) a written examination to test the candidate's factual knowledge of the general areas of mineral processing and his or her ability to synthesize this knowledge in the solution of problems; and (2) an oral examination by the doctoral committee including a presentation, by the candidate, of his or her research problem, relevant literature, data, and future plans. The committee will then examine the candidate concerning the research problem and background knowledge until they are satisfied they can make a decision.

Other Relevant Information

A study panel of three faculty members, including the research adviser, is established for each student. The student and his or her research adviser prepare a proposed program of study, which is discussed and approved at a meeting of the student and the study panel. The student and study panel meet at suitable intervals to review progress and modify the program if necessary.

Student Aid

Graduate assistantships available through this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*. Graduate assistantships in Mineral Processing are generally for research and are usually available to qualified students.

MINERAL PROCESSING (MN PR)

401. MINERAL PROCESS ENGINEERING (3)

410. INTRODUCTION TO QUANTITATIVE MINERAL PROCESSING ENGINEERING ANALYSIS (3)

413. MINERAL PROCESSING LABORATORY (1)

421. PARTICLE TECHNOLOGY LABORATORY (1–3)

424. COAL PREPARATION (3)

425. INTERFACIAL PHENOMENA AND FLOTATION (3)

426. (METAL) AQUEOUS PROCESSING (3)

427. POLLUTION CONTROL IN THE MINERAL PROCESS INDUSTRIES (3)

451. SENIOR PROJECTS (1–6)

496. INDEPENDENT STUDIES (1–18)

497. SPECIAL TOPICS (1–9)

501. INTERFACIAL PHENOMENA IN MINERAL SYSTEMS (3) Applications of surface phenomena to mineral engineering systems. Thermodynamics of surfaces, flotation, adsorption of detergents, electrical double layer, flocculation, dispersion. Prerequisite: CHEM 451.

502. FROTH FLOTATION AND AGGLOMERATION (3) Intensive study of theory and applications of froth flotation and agglomeration. Prerequisite: MN PR 501.

503. COLLOID PHENOMENA (3) Flotation microkinetics; shear, carrier, and selective flocculation; aerosols, foams, and emulsions; spherical agglomeration and emulsion flotation; colloids in hydrometallurgy. Prerequisite: CHEM 451.

505. PHYSICAL SEPARATIONS IN MINERAL PROCESSING (3) Intensive study of theory and applications of gravity, magnetic, electrostatic, centrifugal, and other methods of mineral processing. Prerequisite: MN PR 401.

506. MINERAL PROCESS PLANT DESIGN (3–10) Process design and economy. Development and quantification of flow sheets. Integration of unit operations. Plant layout, equipment selection, and instrumentation. Prerequisite: MN PR 401.

507. (METAL) HYDROMETALLURGICAL PROCESSING (3) Fundamental physicochemical factors underlying the aqueous extraction and recovery of metals and nonmetals from ores, minerals, and scrap metal. Prerequisite: MN PR (METAL) 426.

508. MINERAL PARTICLE SYSTEMS (3) Creation, characterization, separation, and agglomeration of particles. Comminution, sizing, fractionation of powders; surface area, pore size determinations. Agglomeration and balling.

509. PARTICLE–FLUID DYNAMICS (3) Movement of particles in fluids, rheology of non-Newtonian mineral suspensions, design of concentrating devices, fluidized beds, electrodynamic, magnetic separations.

510. SIZE REDUCTION (3) Review of the state of the art in precise design of size reduction devices; their incorporation into mineral processing circuits.

520. MATHEMATICAL MODELING FOR MINERAL PROCESS ENGINEERS (3) Techniques for setting up mathematical models of physical processes of interest in mineral process engineering; analytical and computational methods of solution. Prerequisite: MATH 250.

590. COLLOQUIUM (1–3)

596. INDIVIDUAL STUDIES (1–9)

597. SPECIAL TOPICS (1–9)

598. SPECIAL TOPICS (1–9)

MINING ENGINEERING (MNG E)

H. REGINALD HARDY, JR., *In Charge of Graduate Programs in Mining Engineering*
814-863-1620

Degrees Conferred: Ph.D., M.S., M.Eng.

The Graduate Faculty

Christopher J. Bise, Ph.D. (Penn State) *Professor of Mining Engineering*
H. Reginald Hardy, Jr., Ph.D. (Virginia Tech) *Professor of Mining Engineering*
Jeffrey L. Kohler, Ph.D. (Penn State) *Associate Professor of Mining Engineering*
Jan M. Mutmanský, Ph.D. (Penn State) *Professor of Mining Engineering*
Raja V. Ramani, Ph.D. (Penn State) *Professor of Mining Engineering*

Mining Engineering is one of the graduate programs within the Department of Mineral Engineering. The program objectives are to train students in the methodology of research and to expand the student's knowledge in selected subjects related to research as well as to the entire field of mining engineering.

Areas of specialization in research and course work include computer applications, environmental control, geomechanics and rock mechanics, health and safety, innovative mining systems, materials handling, mine electrical systems, mine maintenance, mine management, mine planning and reclamation, monitoring and control, operations research, surface mining, underground mining, and ventilation. Interests cover coal, metal, and nonmetal mining.

The program has outstanding facilities for mining engineering research. Among these are the Mining Computer Laboratory, the Mine Electrical Research Laboratory, the Rock Mechanics Laboratory, and the Ventilation Laboratory.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are required for admission. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

A B.S. degree in mining engineering or a related engineering field is required for admission at the M.S. level. Applicants lacking a B.S. in mining engineering or a related engineering field will be required to make up deficiencies in basic, related courses. Applicants will be considered for admission based on the strength of their academic record and background (e.g., undergraduate grade-point average, industrial experience, and demonstrated abilities), insofar as resources are available.

A candidacy examination is required of all potential Ph.D. candidates. An M.S. degree in mining engineering or a related engineering field is normally required before candidacy to the Ph.D. program is granted.

Master's Degree Requirements

A student who wants to obtain the M.S. degree is required to prepare a thesis. The thesis must be scholarly, reporting research of a contribution to the discipline, and it must be defended orally in front of an advisory committee of graduate faculty members.

A student who wants to obtain the M.Eng. degree is required to prepare a written report. The report must be a scholarly achievement, relating a developmental study that involves an appropriate, significant subject in the discipline.

Doctoral Degree Requirements

The Ph.D. degree requires a minimum of 12 graduate course credits, beyond the number required for the M.S. degree, and should be taken after successful completion of the Ph.D. candidacy examination. Before taking the Ph.D. candidacy examination, a student must satisfy the requirements of the M.S. degree, have the intellectual support of a faculty member, and have demonstrated high proficiency in written and spoken English. At least 2 additional credits of MNG 590 (Colloquium) also are needed during the period of candidacy.

A comprehensive examination is required of all Ph.D. candidates and should be taken after substantial completion of course work. The examination is the responsibility of the candidate's doctoral committee and takes the form of an oral examination as specified by the Graduate School.

A thesis is required of all Ph.D. candidates. It must be scholarly, reporting original research of significant contribution to the discipline. The ability to do independent research and competence in scholarly

exposition must be demonstrated. The thesis must be defended in a final oral examination that is officially scheduled and announced by the Graduate School.

Other Relevant Information

Continuous registration is required of all graduate students until the thesis or engineering report is approved.

Students in this program may elect the dual-title degree program option in Operations Research for the Ph.D. and M.S. degrees. (*See also* Operations Research.)

Student Aid

Fellowships, traineeships, graduate assistantships, and other forms of financial aid are described in the STUDENT AID section of the *Graduate Bulletin*.

MINING (MNG)

- 400. MINING AND OUR ENVIRONMENT (3)
 - 402. MINE PLANT ENGINEERING (3)
 - 403. MINE POWER SYSTEM DESIGN (3)
 - 404. MINE MATERIALS HANDLING SYSTEMS (2)
 - 406. MINE MONITORING (3)
 - 410. UNDERGROUND COAL EXTRACTION (3)
 - 411. MINE SYSTEMS ENGINEERING (2)
 - 412. EXPLORATION AND ORE ESTIMATION (2)
 - 413. MINING ENGINEERING ECONOMY (1)
 - 422. MINE VENTILATION AND AIR CONDITIONING (3)
 - 431. ROCK MECHANICS (3)
 - 441. SURFACE MINING SYSTEMS AND DESIGN (2)
 - 442. SURFACE MINE SEDIMENTATION CONTROL (2)
 - 443. STRIP MINE CUT PLANNING (2)
 - 444. GROUNDWATER ASPECTS IN MINING (1)
 - 445. ENVIRONMENTAL CONCERNS IN THE MINING INDUSTRY (3)
 - 451W. MINING ENGINEERING PROJECT (1–3)
 - 460. MINE MAINTENANCE ENGINEERING (3)
-
- 502. MINE POWER SYSTEM PROTECTION (3) Protective circuitry, coordination, transient protections, and hazard reduction applied to mine power systems. Prerequisite: MNG 403 or E E 425.
 - 503. MINE POWER EQUIPMENT AND GROUNDING (3) Advanced analysis and design of mine power equipment, protective-relaying systems, and grounding systems. Prerequisites: MNG 502, E E 425.
 - 513. MINE COST ANALYSIS (3) Nature of mining costs, their analysis and control: depreciation and depletion, capital and operating costs, budgets, records.
 - 514. MINE OPERATIONS ANALYSIS (3) Application of operations research techniques in determining optimal design and operating policies for mine management. Prerequisite: MNG 411.
 - 515. MINE SYSTEMS SIMULATION (3) Principles and practices of probabilistic and deterministic simulation in the analysis of operating systems related to mills and mines. Prerequisites: CMPSC 201, MNG 411.
 - 516. MINING GEOSTATISTICS (3) Application of classical and spatial statistics in the study of mine exploration, ore reserve estimation, mining grade control, mine planning, and mine ventilation. Prerequisite: 3 credits of statistics at the 400 level.
 - 541. SURFACE MINE EQUIPMENT SELECTION ANALYSIS (3) Design analysis and selection criteria for principal surface mine equipment, their interaction in operation, and auxiliary equipment requirements. Prerequisites: MNG 441, C E 261.
 - 542. THEORY OF ROCK FRAGMENTATION (3) Behavior of rock under dynamic loads intended to fragment; physical chemistry of explosives; detonation, theory of blasting; design of drill rounds. Prerequisites: E MCH 013, MNG 030, PHYS 203.
 - 545. ROCK MECHANICS INSTRUMENTATION (3) Strain gauge circuitry, transducers, electrohydraulic servo installations, and integrated strain and force measuring systems as applied to rock mechanics. Prerequisite: MNG 431.
 - 554. ROCK MECHANICS DESIGN (3) Engineering design process; design of mines, tunnels, slopes, and underground chambers; guided design concept; creativity and innovation; group design project. Prerequisite: MNG 543.

MUSIC

557. COMPUTATIONAL GEOMECHANICS I (3) Finite element and boundary element analysis of rock mechanics, groundwater flow, and mass transport.
559. CONSOLIDATION OF POROUS MEDIA (2) Coupled fluid flow and deformation behavior of geologic media. Theory and applications in geological, environmental, and petroleum engineering.
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)
598. SPECIAL TOPICS (1-9)
599. FOREIGN STUDY—MINING (1-12, maximum of 24)

MUSIC (MUSIC AND MU ED)

RICHARD D. GREEN, *Director, School of Music*
233 Music Building
814-863-0418

Degrees Conferred: Ph.D., M.A., M.Mus., M.M.E.

The Graduate Faculty

Daniel Armstrong, M.Mus. (Michigan) *Professor of Music*
Eleanor Duncan Armstrong, D.Mus.A. (Michigan) *Associate Professor of Music*
Paul Barsom, Ph.D. (Eastman) *Assistant Professor of Music*
Susan Boardman, D.Mus.A. (Cincinnati) *Associate Professor of Music*
Lisa J. Bontrager, M.Mus. (Michigan) *Associate Professor of Music*
Michael Broyles, Ph.D. (Texas) *Distinguished Professor of Music*
O. Richard Bundy, D.Ed. (Penn State) *Associate Professor of Music Education*
Maureen A. Carr, Ph.D. (Wisconsin) *Professor of Music*
Kim Diane Cook, M.M. (Yale) *Associate Professor of Music*
John Daniel, M.A. (Iowa) *Associate Professor of Music*
Timothy Deighton, D.M.A. (Kansas) *Assistant Professor of Music*
Marylene Dosse (Conservatoire National de Musique de Paris) *Professor of Music*
Lynn Drafall, D.Ed. (Illinois) *Associate Professor of Music Education*
Daryl Durran, M.Mus. (Wisconsin) *Associate Professor of Music*
Dennis Glocke, M.Mus. (Northwestern) *Associate Professor of Music*
Richard D. Green, Ph.D. (Illinois) *Professor of Music*
Taylor Greer, Ph.D. (Yale) *Associate Professor of Music*
Robert Hatten, Ph.D. (Indiana) *Associate Professor of Music*
Timothy Hurtz, B.Mus. (USC) *Associate Professor of Music*
Pu-Qi Jiang, M.Mus. (Cincinnati) *Associate Professor of Music*
Richard Kennedy, M.Mus. (Indiana) *Associate Professor of Music*
Anthony Leach, Ph.D. (Penn State) *Assistant Professor of Music*
Mark Lusk, M.Mus. (Eastman) *Associate Professor of Music*
James Lyon, M.M. (West Texas) *Associate Professor of Music*
Eric J. McKee, Ph.D. (Michigan) *Assistant Professor of Music*
D. Douglas Miller, D.Mus. (Indiana) *Professor of Music*
June Miller, M.Mus. (Yale) *Associate Professor of Music*
Dale Monson, Ph.D. (Columbia) *Associate Professor of Music*
M. Suzanne Roy, D.Mus.A. (Wisconsin) *Associate Professor of Music*
Joanne Rutkowski, Ph.D. (SUNY, Buffalo) *Associate Professor of Music*
Timothy Shafer, D.Mus. (Indiana) *Associate Professor of Music*
Steven H. Smith, D.Mus.A. (Eastman) *Professor of Music*
Norman Spivey, D.Mus.A. (Michigan) *Associate Professor of Music*
David Teachout, Ph.D. (Kent State) *Assistant Professor of Music Education*
Keith P. Thompson, Ph.D. (Case Western Reserve) *Professor of Music Education*
Smith C. Toulson III, M.Mus. (Yale) *Professor of Music*
W. Bruce Trinkley, M.A. (Columbia) *Professor of Music*
Edward V. Williams, Ph.D. (Yale) *Professor of Music*
M. Daniel Yoder, M.Mus. (Idaho) *Professor of Music*

Admission Requirements

In addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*, the School of Music requires the completion of a recognized baccalaureate degree in music or music education, with a junior/senior grade-point average of 2.80 or higher (on a 4.00 scale). Admission to the M.Mus. program requires an audition or the submission of manuscripts; admission to the M.M.E. program requires the completion of 12 credits in music education methods and successful teaching experience; admission to the Ph.D. requires an interview and submission of videotapes of teaching or conducting, the Miller Analogies Test, and a portfolio of requested documents; admission to the M.A. program requires scores from the GRE aptitude test and the advanced test in music and evidence of scholarly writing on a musical topic. Additional requirements for entrance to the various degree programs can be obtained from the School of Music office.

Master's Degree Requirements

Two programs leading to the master of arts degree are offered. The M.A. in Musicology (32 credits) is directed toward research. The M.A. in Music Theory and History (34 credits) integrates historical, theoretical, and analytical approaches to musical styles and works. A reading knowledge of German or another appropriate language must be demonstrated before thesis credit may be scheduled. Both programs require a thesis.

The M.M.E. degree in Music Education (30 credits) provides opportunity for advanced study in the art of music, pedagogy, and systematic problem solving. A "summers only" enrollment option is available. A master's paper is required.

The M.Mus. degree (36 credits) provides five majors: Performance, Composition, Conducting, Piano Pedagogy and Performance, and Voice Performance and Pedagogy. Depending on the major, a recital, a composition project, or a conducting project is required. In addition, a master's paper or a lecture-recital is required for all M.Mus. candidates.

In all master's programs, at least one-half the required credits must be at the 500 level, and a comprehensive examination is required.

Doctoral Degree Requirements

The Ph.D. in Music Education is designed to provide opportunities for the highest level of scholarly study in the processes of teaching and learning music. Candidates are expected to develop and test new knowledge in the field of music education while preparing themselves for positions in higher education or other leadership roles within the profession. Individual programs of study are designed on the basis of a candidacy examination. A doctoral thesis and comprehensive written and oral examinations are required.

Other Relevant Information

The School of Music sponsors many musical ensembles, and candidates for degrees are required to participate in positions of responsibility. All candidates for degrees are expected to be in residence for a minimum of two semesters.

The School of Music is an accredited institutional member of the National Association of Schools of Music.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

MUSIC (MUSIC)

Individualized instruction is offered in six categories covering nineteen instruments:

Brass (Brass)	Trumpet, French horn, trombone, euphonium, tuba
Keyboard (Keybd)	Piano, organ, harpsichord
Strings (Strng)	Violin, viola, violoncello, double bass
Woodwinds (Wwnds)	Flute, oboe, clarinet, bassoon, saxophone
Percussion (Percn)	
Voice (Voice)	

Instruction is offered for each instrument in three different modes: Secondary for 1 credit, Secondary for 2 credits, and Performance for 4 credits.

The Performance mode is available only to M.Mus. (Performance) students in their major areas. All other students take Secondary for 1 or 2 credits.

MUSIC

Applied music fees are required for individual instruction: \$100 for a 1-credit course, \$150 for a 2-credit course, and \$150 for a 4-credit course.

Examples of listings follow.

Course Abbreviation	Number & Suffix	Instrument	Mode	Credit	Fee
KEYBD	500J	Piano	Secondary	1	\$100
KEYBD	510J	Piano	Secondary	2	150
KEYBD	530J	Piano	Performance	4	150
KEYBD	501J	Organ	Secondary	1	100
KEYBD	511J	Organ	Secondary	2	150
KEYBD	531J	Organ	Performance	4	150
KEYBD	502J	Harpsichord	Secondary	1	100
KEYBD	512J	Harpsichord	Secondary	2	150
KEYBD	532J	Harpsichord	Performance	4	150

A complete list can be obtained from the School of Music office.

412. JAZZ PEDAGOGY (2)
414. STRING PEDAGOGY (1-2)
415. WOODWIND PEDAGOGY (1-2)
416. BRASS PEDAGOGY (1-2)
417. PERCUSSION PEDAGOGY (1-2)
418. VOCAL PEDAGOGY (2)
419. PIANO PEDAGOGY I (2)
420. VOCAL ACCOMPANYING TECHNIQUES (2)
421. JAZZ COMBO CLASS (1)
422. JAZZ HARMONY AND ARRANGING (3)
424. PIANO PEDAGOGY II (2)
425. ADVANCED VOCAL PEDAGOGY (2)
428. GRADUATE REVIEW OF TONAL ANALYSIS (2)
429. AURAL REVIEW FOR GRADUATE STUDENTS (1)
430. HARMONY REVIEW FOR GRADUATE STUDENTS (2)
431. ADVANCED TONAL ANALYSIS (2-3)
432. GRADUATE REVIEW OF TWENTIETH-CENTURY ANALYSIS (2-3)
433. ADVANCED ANALYSIS OF TWENTIETH-CENTURY MUSIC (2-3)
435. SCORE READING (1)
438. FIGURED BASS (2)
450. TEACHING MARCHING BAND (3)
458. ELECTRONIC MUSIC (3)
459. PROJECT IN ELECTRONIC MUSIC (1-3 per semester, maximum of 12)
- 461W. STUDIES IN MUSIC HISTORY: ANTIQUITY TO 1600 (3)
- 462W. STUDIES IN MUSIC HISTORY: 1550-1750 (3)
- 463W. STUDIES IN MUSIC HISTORY: 1700-1900 (3)
- 464W. STUDIES IN MUSIC HISTORY: 1850-PRESENT (3)
465. ADVANCED CONDUCTING I (2)
466. ADVANCED CONDUCTING II (2)
467. OPERA WORKSHOP (1-3 per semester, maximum of 6)
471. STRUCTURAL AND SIXTEENTH-CENTURY COUNTERPOINT (2)
472. EIGHTEENTH-CENTURY COUNTERPOINT (2)
473. COMPOSITION VII (3)
474. COMPOSITION VIII (3)
- 476W. B.A. SENIOR PROJECT (3)
478. VOCAL LITERATURE (3)
480. OPERA LITERATURE (3)
481. KEYBOARD LITERATURE (3)
482. SEMINAR IN KEYBOARD LITERATURE (2)
483. SEMINAR IN VOCAL PEDAGOGY LITERATURE (2)
485. CHAMBER MUSIC LITERATURE (3)

487. ORCHESTRAL LITERATURE (3)
489. STUDIO AND RECITAL ACCOMPANIMENT (1 per semester, maximum of 4)
493. SONATA DUOS (1 per semester, maximum of 4)
494. RESEARCH TOPICS (1–3)
- 495A. STUDENT TEACHING: GENERAL MUSIC (6–8)
- 495B. STUDENT TEACHING: CHORAL MUSIC (6–8)
- 495C. STUDENT TEACHING: INSTRUMENTAL MUSIC (6–8)
496. INDEPENDENT STUDIES (1–18)
497. SPECIAL TOPICS (1–9)
500. INTRODUCTION TO MUSIC REFERENCE AND RESEARCH MATERIALS (2) A study of musicological reference and research materials in English and Western European languages, with exercises in their use.
- *503. CONCERT CHOIR (1 per semester, maximum of 4)
- *504. CHAMBER SINGERS (1 per semester, maximum of 4)
- *505. SYMPHONIC WIND ENSEMBLE (1 per semester, maximum of 4)
- *506. SYMPHONIC BAND (1 per semester, maximum of 4)
- *507. PHILHARMONIC ORCHESTRA (1 per semester, maximum of 4)
- *508. CHAMBER ORCHESTRA (1 per semester, maximum of 4)
- *509. CENTRE DIMENSIONS (1 per semester, maximum of 4)
- *510. BRASS CHOIR (1 per semester, maximum of 4)
- *511. PERCUSSION ENSEMBLE (1 per semester, maximum of 4)
- *520. CHAMBER MUSIC FOR STRINGS (1–4)
- *521. CHAMBER MUSIC FOR WOODWINDS (1–4)
- *522. CHAMBER MUSIC FOR BRASS (1–4)
- *523. SONATA DUOS (1)
531. ANALYTICAL TECHNIQUES (3) Twentieth-century theories of tonal music other than Schenker; emphasis on motivic, thematic, metric, and rhythmic analysis.
532. SCHENKERIAN ANALYSIS (3) an intensive introduction to the analytical method developed by the twentieth-century Austrian theorist and musicologist, Heinrich Schenker.
533. THE PEDAGOGY OF UNDERGRADUATE THEORY AND HISTORY (2) A study of approaches to the teaching and learning of music theory (written and aural skills) and history. Prerequisites: MUSIC 262, 331.
535. COMPOSITION (1–4) Composition for vocal, instrumental, and electronic media and preparation of compositions for performance. Prerequisite: MUSIC 474.
540. IDENTIFYING AND INTERPRETING RESEARCH (2) An introduction to research in music education with an emphasis on understanding research processes, dissemination of research, retrieval of research reports, and interpretation of research data and results.
541. CONTEMPORARY MUSIC CURRICULA (3) Developing music curricula incorporating current theories, practices, materials, and research data.
542. TEACHING GENERAL MUSIC (2) An examination of teaching strategies and materials, current trends and research on general music programs in public schools.
543. TEACHING CHORAL MUSIC (2) In-depth study of musical and administrative aspects of choral programs for grades 4–12.
544. TEACHING INSTRUMENTAL MUSIC (2) An examination of teaching strategies, materials, current trends, and research on instrumental music programs in public schools.
545. PSYCHOLOGICAL FOUNDATIONS OF MUSICAL BEHAVIOR (3) Study of psychoacoustical effects of musical stimuli; emphasis on responses affecting learning musical ability, musical taste, and aesthetic reactions.
546. ASSESSMENT OF MUSIC LEARNING (2) Consideration of the unique problems involved in the assessment of music learning. Exploration of processes and techniques for assessing the acquisition of musical skill and knowledge.
550. MASTER'S SEMINAR IN MUSIC EDUCATION (1) Forum for the discussion of issues and procedures necessary for the systematic examination of problems related to the teaching of music. Prerequisite: MUSIC 540.
547. THE MATERIALS OF APPRECIATION (3) Examination of written and recorded materials and appropriate techniques for developing appreciation of music at elementary, secondary, and college levels.

*Admission by audition.

551. ADMINISTRATION AND SUPERVISION OF SCHOOL MUSIC (3) Examination procedures for effective supervision of music instruction and administration of school music programs. Prerequisite: five years of music teaching in public schools.
552. INTERNSHIP IN MUSIC SUPERVISION (3–6) Internship in schools under supervision of graduate faculty in music education. Prerequisites: MUSIC 551, C & S 560.
555. DOCTORAL SEMINAR IN MUSIC EDUCATION (1 per semester, maximum of 6) Forum for the discussion of problems in theory and design encountered in individual and group research projects.
559. CONTEMPORARY ISSUES IN MUSIC EDUCATION (1) Consideration of the current political and pedagogical issues that influence curriculum development, teaching, and administration of K-12 music programs.
- **560. CHORAL CONDUCTING (2–4 per semester, maximum of 16) Study of choral conducting techniques, comprehensive score analysis, and supervised rehearsal and performance practicum. Prerequisite: MUSIC 466 or admission by audition.
- **561. ORCHESTRAL CONDUCTING (2–4 per semester, maximum of 16) Study of orchestral conducting technique, comprehensive score analysis, and supervised rehearsal and performance practicum.
- **562. BAND/WIND ENSEMBLE CONDUCTING (2–4 per semester, maximum of 16) Study of band and wind ensemble conducting, comprehensive score analysis, and supervised rehearsal and performance practicum.
- **565. STUDIO AND RECITAL ACCOMPANIMENT (1) Keyboard accompaniment of student soloists in the studio and in public performance, under faculty supervision.
572. SEMINAR IN MUSICOLOGY (3 per semester, maximum of 9) Research in selected areas of music history.
573. INTEGRATIVE SEMINAR IN MUSIC THEORY AND HISTORY (3) Special topics (composer, style, genre) taught from both theoretical and historical perspectives.
575. INTEGRATIVE CONDUCTING SEMINAR (1 per semester, maximum of 2) A seminar for choral, orchestral, and band/wind ensemble graduate conducting majors, taught by conducting faculty in all three areas.
580. STUDIES IN ORCHESTRAL LITERATURE (1–3) Selected studies in orchestral literature from the seventeenth century to the present.
582. STUDIES IN BAND/WIND ENSEMBLE LITERATURE (2–3 per semester/ maximum of 8) Selected studies in band and wind ensemble literature from the Renaissance to the present.
583. STUDIES IN CHORAL LITERATURE (2–3 per semester, maximum of 20) Selected studies in choral literature of all types from the Renaissance to the present.
588. SEMINAR IN MUSIC LITERATURE OF THE MAJOR PERFORMANCE AREA (1–3) Selected studies in music literature specific to the student's major performance area. Will include research, analysis, and performance.
589. SEMINAR IN PIANO PEDAGOGY (2) Selected variable topics in piano pedagogy. Includes research, performance and discussion of appropriate literature, and class participation.
590. COLLOQUIUM (1–3)
591. GRADUATE DEGREE PERFORMANCE (1) A juried recital performance for students majoring in performance, composition, or conducting. Prerequisite: consent of the department.
594. MASTER'S PAPER RESEARCH (1–6) Investigation of a specific problem in music or music education.
595. INTERNSHIP (1–18)
596. INDIVIDUAL STUDIES (1–9)
597. SPECIAL TOPICS (1–9)

NEUROSCIENCE (NEURO)

ROBERT J. MILNER, *Director of Neuroscience Program, Chair of the Department of Neuroscience and Anatomy*
 College of Medicine, University Hospital
 The Milton S. Hershey Medical Center
 Hershey, PA 17033
 717-531-8650

Degrees Conferred: Ph.D., M.S.

**Course may be scheduled only after consultation with the director of the School of Music.

The Graduate Faculty

- Kevin D. Alloway, Ph.D. (Indiana) *Associate Professor of Neuroscience and Anatomy*
 Helen A. Baghdoyan, Ph.D. (Connecticut) *Professor of Neuroscience and Anatomy*
 John Beard, Ph.D. (Cornell) *Professor of Nutrition Science*
 Melvin L. Billingsley, Ph.D. (George Washington) *Professor of Pharmacology*
 Edward O. Bixler, Ph.D. (New Mexico) *Professor of Psychiatry*
 Robert H. Bonneau, Ph.D. (Penn State, Hershey) *Assistant Professor of Microbiology and Immunology*
 John B. Connor, Ph.D. (California, Berkeley) *Professor of Neuroscience and Anatomy*
 John D. Connor, Ph.D. (Phila. College of Pharmacy and Science) *Professor of Pharmacology*
 Jonathan R. Day, Ph.D. (Univ. of Delaware) *Assistant Professor of Biology*
 Steven P. Dear, Ph.D. (Pennsylvania) *Assistant Professor of Neuroscience and Anatomy*
 Waldemar Debinski, M.D., Ph.D. (McGill) *Assistant Professor of Surgery (Neurosurgery)*
 Barry R. Dworkin, Ph.D. (Rockefeller) *Professor of Behavioral Science and Psychology*
 Paul J. Eslinger, Ph.D. (Texas Christian) *Professor of Neurology and Behavioral Science*
 Andrew Ewing, Ph.D. (Indiana University) *Professor of Chemistry*
 Thomas Frielle, Ph.D. (Pittsburgh) *Assistant Professor of Pharmacology*
 Laszlo Geder, M.D., Ph.D. (Debrecen, Hungary) *Assistant Professor of Medicine, Microbiology, and Immunology*
 Patricia S. Grigson, Ph.D. (Rutgers) *Assistant Professor of Behavioral Science*
 Ellen J. Hess, Ph.D. (California, San Diego) *Associate Professor of Neuroscience and Anatomy*
 Byron C. Jones, Ph.D. (Arizona) *Professor of Biobehavioral Health*
 John C. Keifer, M.D. (North Carolina, Chapel Hill) *Associate Professor of Anesthesia*
 Joan Lakoski, Ph.D. (Iowa) *Associate Professor of Pharmacology*
 Kathryn F. LaNoue, Ph.D. (Yale) *Professor of Cellular and Molecular Physiology*
 Alphonse E. Leure-duPree, Ph.D. (London, England) *Professor of Neuroscience and Anatomy*
 Robert Levenson, Ph.D. (SUNY, Stony Brook) *Professor of Pharmacology*
 Steve Levison, Ph.D. (North Carolina, Chapel Hill) *Assistant Professor of Neuroscience and Anatomy*
 Erich Lieth, Ph.D. (North Carolina, Chapel Hill) *Assistant Professor of Neuroscience and Anatomy*
 Ralph Lydic, Ph.D. (Texas Tech) *Professor of Anesthesia and Cellular and Molecular Physiology*
 Patricia McLaughlin, D.Ed. (Penn State, Harrisburg) *Associate Professor of Neuroscience and Anatomy*
 Robert J. Milner, Ph.D. (Rockefeller) *Professor of Neuroscience and Anatomy*
 Ralph Norgren, Ph.D. (Michigan) *Professor of Behavioral Science*
 Richard W. Ordway, Ph.D. (U. Mass. Medical School) *Assistant Professor of Biology*
 Ann Ouyang, M.B., B.S. (London) *Professor of Medicine*
 Robert B. Page, M.D. (Columbia) *Professor of Surgery (Neurosurgery), and Neuroscience and Anatomy*
 Stephen K. Powers, M.D. (Ohio State) *Professor of Surgery (Neurosurgery)*
 Thomas C. Pritchard, Ph.D. (Delaware) *Assistant Professor of Behavioral Science*
 Cara-Lynne Schengrund, Ph.D. (Seton Hall) *Professor of Biochemistry and Molecular Biology*
 Walter B. Severs, Ph.D. (Pittsburgh) *Professor of Pharmacology*
 Joan Y. Summy-Long, Ph.D. (Penn State, Hershey) *Professor of Pharmacology*
 Richard B. Tenser, M.D. (SUNY, Syracuse) *Professor of Medicine, and Microbiology and Immunology*
 Robert C. Vannucci, M.D. (Thomas Jefferson) *Professor of Pediatrics*
 Susan Vannucci, Ph.D. (Penn State) *Associate Professor of Pediatrics and Cellular and Molecular Physiology*
 Judith Weisz, M.B., B. Chir. (Cambridge, England) *Professor of Obstetrics and Gynecology*
 Brian L. Wigdahl, Ph.D. (Medical College of Wisconsin) *Professor of Microbiology and Immunology*
 Teresa Wood, Ph.D. (UCLA) *Assistant Professor of Neuroscience and Anatomy*
 Ian S. Zagon, Ph.D. (Colorado) *Professor of Neuroscience and Anatomy*

The Neuroscience program is an interdepartmental program within the College of Medicine that is designed to enable students to take an integrated series of courses leading to the M.S., Ph.D., or M.D./Ph.D. degree. The program encompasses not only fundamentals of neuroscience but advanced training in a specialized area as well. All courses are available in the College of Medicine. The basic courses in anatomy, behavioral science, biochemistry, pharmacology, and physiology, in addition to an introduction to neuroscience, constitute a core program of study and are considered requisite to the initiation of a meaningful research experience. Students are also exposed in depth to one of the basic science disciplines (anatomy, biological chemistry, pharmacology, physiology, microbiology and immunology, or behavioral science). Expertise in one of those disciplines allows graduates to function as faculty members in a department of neuroscience or in the selected basic science department. Degree candidates undertake a major in neuroscience and a minor in the selected basic science discipline.

Admission Requirements

Candidates for admission should request application material from the program director. Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by the graduate program and authorized by the dean of the Graduate School (e.g., MCAT exam), are required for admission. At the discretion of the graduate program, a student may be admitted provisionally for graduate study without these scores. Applicants are expected to have taken courses in biology, general and organic chemistry, mathematics, and general physics. Neuroscience courses are desirable but not essential. Candidates must have a 3.00 (B) grade-point average (on a 4.00 scale) or better. Qualified applicants generally are requested to visit the program for an interview prior to acceptance decisions. Admission is based on evaluation by the Neuroscience Advisory Committee of the undergraduate transcript, GRE scores, personal statement of purpose, letters of recommendation, and interviews. International students must provide evidence of proficiency in English with a minimum score of 550 on the TOEFL examination. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Doctoral Degree Requirements

The formal course requirements depend upon the individual student's career goals. To be retained in the program and to continue to receive financial support, a student must maintain a B average. The student must also participate actively in the seminar program. In addition, the student must complete successfully: (a) a candidacy examination covering the general course material that will consist of a written test of factual knowledge (The examination will be given at the end of the spring semester of the first year after the student has completed the required basic courses.); (b) a communications requirement, to be completed after the candidacy examination; (c) a comprehensive examination consisting of a written research proposal and an oral defense of that proposal covering a specific topic relevant to, but not the same as, the student's research that will be required after completion of the spring semester of the second year; (d) a research project consisting of an original investigation under the supervision of a neuroscience faculty adviser; (e) a thesis; and (f) a final oral defense of the thesis. The program is designed to be completed in four years, but this can vary depending on the individual progress of the student.

Student Aid

Graduate research assistantships are provided for qualified students each year. In addition, full tuition is provided. This level of support is sufficient to allow students to devote full time to graduate studies. All support is continuous for the first two years from the Neuroscience program. Support in years three and four, when the student is conducting thesis research, must be acquired from either the basic science department in which the candidate elects to pursue his/her minor or from funds available from the thesis adviser. These funds must be secured by the student in conjunction with his/her adviser. Other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

NEUROSCIENCE (NEURO)

510. (PSIO) NEUROBIOLOGY I (2) A general discussion on the cellular and molecular nature of the various aspects of neurophysiology.

511. (ANAT) NEUROBIOLOGY II (3) Structure and physiology of central and peripheral nervous systems, including specific sense organs.

515. (ANAT) DEVELOPMENTAL NEUROBIOLOGY (2) Development of the nervous system in all its aspects.

520. CELLULAR AND MOLECULAR NEUROSCIENCE (3) An introduction to neurons, glia, and the molecular basis of brain function.

521. SYSTEMS NEUROSCIENCE (3) An introduction to the major neural systems and their integrative functions. Prerequisite: NEURO 520.

522. CELL, MOLECULAR, AND METABOLIC ELEMENTS OF NEUROSCIENCE III—NEURONAL NETWORKS, PATHWAYS, AND INTEGRATION (2) Study at the cellular, molecular, and metabolic level of selected subjects in neuroscience.

523. CELL, MOLECULAR, AND METABOLIC ELEMENTS OF NEUROSCIENCE IV—DEVELOPMENT, LEARNING, AND BEHAVIOR (2) Study at the cellular, molecular, and metabolic level of selected subjects in neuroscience.

526. (PSIO) MOLECULAR NEUROSCIENCE (2) An in-depth discussion of the molecular nature of the various components of neurotransmission. Prerequisite: PSIO 510 or NEURO 510.

527. (PSIO) NEUROBIOLOGY OF THE VISUAL SYSTEM (2) This course provides a detailed knowledge of the molecular and cellular mechanism of the visual processes. Prerequisite: PSIO 510 or NEURO 510.

528. (BCHEM) NEUROCHEMISTRY (3) Study at the molecular level of processes that permit cells of the central nervous system to perform their unique functions. Prerequisites: BCHEM 502, 505; PSIO 510 or NEURO 510.
529. (BEHSC) NEURAL BASES OF BEHAVIOR (2) Study of neural mechanisms that control an organism's interaction with the external environment. Prerequisite: PSIO 510 or NEURO 510. Prerequisite or concurrent: ANAT 511 or NEURO 511.
542. (ANAT) COMPARATIVE NEUROLOGY (3) Topics in functional anatomy and neurophysiology; the comparative approach to the organization of the mammalian nervous system will be stressed. Prerequisite: ANAT 511 or NEURO 511.
543. (ANAT) SENSORY PROCESSES (3) Morphological, physiological, and psychological aspects of mammalian sensory systems, emphasizing somatic, sensory, visual, and auditory systems. Prerequisite: ANAT 511 or NEURO 511.
545. (ANAT) COMPARATIVE AUDITORY AND VISUAL ANATOMY (3) An introduction to the morphology and evolution of the vertebrate eye and ear; individualized laboratory work arranged by consultation.
550. (PHARM) NEUROPHARMACOLOGY (3) Study of mechanisms of action of drugs that alter neuronal transmission in the peripheral and central nervous systems. Prerequisite: NEURO 510 or PSIO 510.
590. COLLOQUIUM (1-3)
594. RESEARCH TOPICS (1-9)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

NUCLEAR ENGINEERING (NUC E)

ANTHONY J. BARATTA, *Chair of NUCE*
231 Sackett Building
814-865-4911

Degrees Conferred: Ph.D., M.S., M.Eng.

The Graduate Faculty

Anthony J. Baratta, Ph.D. (Brown) *Professor of Nuclear Engineering*
Gary L. Catchen, Ph.D. (Columbia) *Professor of Nuclear Engineering*
Ward S. Diethorn, Ph.D. (Carnegie Tech.) *Professor Emeritus of Nuclear Engineering*
Robert M. Edwards, Ph.D. (Penn State) *Associate Professor of Nuclear Engineering*
Madeline A. Feltus, Ph.D. (Columbia) *Assistant Professor of Nuclear Engineering*
Alireza Haghighat, Ph.D. (Washington) *Professor of Nuclear Engineering*
Lawrence E. Hochreiter, Ph.D. (Purdue) *Professor of Nuclear and Mechanical Engineering*
Kostadin N. Ivanov, Ph.D. (Bulgarian Academy of Sciences) *Assistant Professor of Nuclear Engineering*
William A. Jester, Ph.D. (Penn State) *Professor of Nuclear Engineering*
Edward S. Kenney, Ph.D. (Penn State) *Professor Emeritus of Nuclear Engineering*
Edward H. Klevans, Ph.D. (Michigan) *Professor Emeritus of Nuclear Engineering*
Samuel H. Levine, Ph.D. (Pittsburgh) *Professor Emeritus of Nuclear Engineering*
John H. Mahaffy, Ph.D. (Colorado) *Associate Professor of Nuclear Engineering*
Arthur M. Motta, Ph.D. (California, Berkeley) *Associate Professor of Nuclear Engineering*
Bojan Petrovic, Ph.D. (Penn State) *Research Associate*
G. E. Robinson, Ph.D. (Penn State) *Professor Emeritus of Nuclear Engineering*
Barry Earl Scheetz, Ph.D. (Penn State) *Professor of Materials; Senior Scientist, Materials Research Laboratory; Professor of Civil and Nuclear Engineering*

Graduate programs and research facilities are available in thermal-hydraulics, neutronics, computational methods, advanced controls with applications of artificial intelligence, materials, radiation monitoring and effects, fuel management, and radioactive waste management. Application areas include advanced reactor design, safety analysis, radiation instrumentation development, and plant life extension.

Admission Requirements

Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for

admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Students with a 2.50 junior/senior grade-point average and with appropriate course backgrounds will be considered for admission. General aptitude GRE test results are required. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

Degree Requirements

The department offers three degrees at the master's level: M.Eng., M.S. with paper, and M.S. with thesis. The communication requirement for the Ph.D. degree may be satisfied by proficiency in English. Continuous registration is required for all graduate students until the thesis or engineering report is approved.

Student Aid

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AID section of the *Graduate Bulletin*, the following awards typically have been available to graduate students in this program:

NATIONAL ACADEMY FOR NUCLEAR TRAINING FELLOWSHIPS—Available to graduate students in nuclear engineering; stipend plus tuition.

U.S. DEPARTMENT OF ENERGY—NUCLEAR SCIENCE AND ENGINEERING FELLOWSHIPS—Available to graduate students interested in engineering and engineering support related to nuclear technology; stipend plus tuition.

NUCLEAR ENGINEERING (NUC E)

- 401. INTRODUCTION TO NUCLEAR ENGINEERING (3)
- 403. ADVANCED REACTOR DESIGN (3)
- 405. (CHEM) NUCLEAR AND RADIOCHEMISTRY (3)
- 408. RADIATION SHIELDING (3)
- 409. (METAL) NUCLEAR MATERIALS (3)
- 420. RADIOLOGICAL SAFETY (3)
- 428. RADIOACTIVE WASTE CONTROL (3)
- 430. DESIGN PRINCIPLES OF REACTOR SYSTEMS (3)
- 431W. NUCLEAR REACTOR CORE DESIGN SYNTHESIS (4)
- 444. NUCLEAR REACTOR OPERATIONS LABORATORY (1)
- 445. NUCLEAR DIGITAL INSTRUMENTATION (3)
- 450. RADIATION DETECTION AND MEASUREMENT (3)
- 451. EXPERIMENTS IN REACTOR PHYSICS (3)
- 460. NUCLEAR SYSTEMS RISK ASSESSMENT (3)
- 470. POWER PLANT SIMULATION (3)
- 490. (AERSP, E E) INTRODUCTION TO PLASMAS (3)
- 494. SENIOR THESIS (1–9)
- 496. INDEPENDENT STUDIES (1–18)
- 497. SPECIAL TOPICS (1–9)

501. REACTOR ENGINEERING (3) Thermal hydraulic fundamentals including thermal hydraulic characteristics of power reactors, thermal design principles, reactor heat generators, thermal analysis of fuel elements and size and two-phase heat transfer in heated channels. Prerequisites: NUC E 302; NUC E 430.

505. REACTOR INSTRUMENTATION AND CONTROL (3) Reactor control principles; classical control methods; operational control problems; control simulation using modern mainframe and micro-computer software packages; reactor instrumentation. Prerequisite: NUC E 302 or NUC E 401.

506. NUCLEAR CHEMISTRY (3) Energetics, kinematics, and models of nuclear reactions; nuclear processes as chemical probes, Mossbauer effect, and perturbed angular correlation spectroscopy.

512. NUCLEAR FUEL MANAGEMENT (3) Develop advanced techniques for reloading nuclear reactors using sophisticated neutronic codes. Emphasis on calculational techniques in reactor optimization and design, and economic value through the fuel cycle. Prerequisite: NUC E 302.

521. NEUTRON TRANSPORT THEORY (3) Derivation of Boltzmann equation for neutron transport; techniques of approximate and exact solution for the monoenergetic and spectrum regenerating cases. Prerequisite: NUC E 403 or PHYS 406.

525. MONTE CARLO METHODS (3) Fundamentals of the probability theory and statistics, analog and non-analog Monte Carlo methods and their applications, random processes, and numbers. Prerequisites: CMPSC 201, MATH 141, NUC E 309, or STAT 401.

530. PARALLEL/VECTOR ALGORITHMS FOR SCIENTIFIC APPLICATIONS (3) Development/analysis of parallel/vector algorithms (finite-differencing of PDEs and Monte Carlo methods) for engineering/scientific applications for shared and distributed memory architectures. Prerequisite: AERSP 424 or CSE 457.

540. (AERSP, E E) THEORY OF PLASMA WAVES (3) Coulomb interaction in plasmas; kinetic equations; collisionless plasmas as dielectric media; longitudinal plasma waves; transverse plasma waves. Prerequisite: NUC E (AERSP, E E) 490.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

B. ADVANCED THERMAL HYDRAULIC ANALYSIS OF LWRs (3)

C. PROFESSIONAL TOPICS IN NUCLEAR ENGINEERING (3)

D. NUCLEAR REACTOR SAFETY (3)

E. POWER PLANT DYNAMICS AND CONTROL (3)

G. ENVIRONMENTAL DEGRADATION OF MATERIALS IN NUCLEAR POWER PLANTS (3)

I. POWER PLANT INTELLIGENT DISTRIBUTED CONTROL (3)

K. NUCLEAR REACTOR KINETICS AND DYNAMICS (3)

NURSING (NURS)

SARAH H. GUELDER, *Director, School of Nursing*

201 Health and Human Development East Building

814-863-0245

Degree Conferred: M.S. (thesis or scholarly paper option)

The Graduate Faculty

Theresa Balog, Ph.D. (Pittsburgh) *Assistant Professor of Nursing*

Quincealea Brunk, Ph.D. (Texas) *Assistant Professor of Nursing*

Mary Beth Clark, Ed.D. (Temple) *Assistant Professor of Nursing*

Cheryl A. Dellasega, Ph.D. (Temple) *Associate Professor of Nursing*

Kathleen Fisher, Ph.D. (Penn State) *Assistant Professor of Nursing*

Gail Havens, Ph.D. (Maryland) *Assistant Professor of Nursing*

Frieda M. Holt, Ed.D. (Boston) *Professor of Nursing*

Judith E. Hupcey, Ed.D. (Columbia) *Assistant Professor of Nursing*

Kathleen G. Mastrian, Ph.D. (Kent State) *Assistant Professor of Nursing*

Dee M. McGonigle, Ph.D. (Pittsburgh) *Associate Professor of Nursing*

Janice M. Morse, Ph.D. (Utah) *Adjunct Professor of Nursing and Behavioral Science*

Jana Pressler, Ph.D. (Case Western) *Assistant Professor of Nursing*

Joan A. Panchal, Ph.D. (Pittsburgh) *Assistant Professor of Nursing*

Deborah B. Preston, Ph.D. (Penn State) *Associate Professor of Health Education and Nursing*

Elizabeth J. Susman, Ph.D. (Penn State) *Jean Phillips Shibley Professor of Biobehavioral Health and Professor of Nursing*

The master of science degree is offered in recognition of the completion of a program that emphasizes productive scholarship and research in preparation of the advanced practice nurse. The graduate program emphasizes the development of nursing knowledge and the translation of knowledge into practice. It provides advanced study in human health and development throughout the life span, and in nursing's role in providing health services to individuals, families, and communities. Applicants may apply to one of the four tracks offered within the major of Nursing: Adult/Older Adult Health, Community Health, Family Nurse Practitioner, or Neonatal Nurse Practitioner. The graduate program in Nursing is accredited by the National League for Nursing (NLN).

The Neonatal Nurse Practitioner and Family Nurse Practitioner tracks are designed to help prepare the professional nurse to function in an expanded nursing role as a nurse practitioner providing direct care to specific groups of clients in both primary and acute care settings. Since that practice is inherently interdisciplinary in nature, advanced knowledge and research from nursing is combined with knowledge from the science, medicine, and related disciplines.

The Adult/Older Adult Health Nursing and Community Health Nursing tracks prepare graduates to provide expertise in their specialty field to plan, implement, and evaluate care in a variety of settings. They function in direct care, supervisory, consultative, teaching, and research roles serving individuals, families, and communities. Their knowledge and research are focused within their specialty area.

A minor in Nursing is offered at the doctoral level.

Admission Requirements

Basic admission requirements for the master of science degree in Nursing include scores from the Graduate Record Examination (GRE), a baccalaureate degree in Nursing from an NLN-accredited program, and a junior/senior grade-point average of 3.00 (on a 4.00 scale). Courses in assessment, basic statistics, and introduction to research are required. A current Pennsylvania registered nurse license and evidence of current liability insurance are also required. Two letters of reference and a brief essay are also part of the application. Applicants who do not meet the established criteria may be considered on an individual basis. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Additional requirements are specified by each nurse practitioner option. For the Neonatal Nurse Practitioner (NNP) applicant, a minimum of two years' experience in a Level II Neonatal Nursery is required, in addition to references from nurse supervisors who can speak to the applicant's suitability for the NNP role, and previous clinical experience. The Family Nurse Practitioner track requires a minimum of two years' experience as a professional nurse.

Degree Requirements

A core of courses including nursing issues, theory, and research is required of all students. Candidates in the Adult/Older Adult Health or Community Health tracks must earn a minimum of 36 credits. In the Neonatal Nurse Practitioner track, they must earn a minimum of 51 credits, and in the Family Nurse Practitioner track, they must earn a minimum of 56 credits. Students in all tracks may choose to do either a thesis for 6 credits or a scholarly paper for 3 credits. The scholarly paper option is designed to be as academically rigorous as the thesis option. A scholarly paper demonstrates the application of theory and research to a clinical problem based on review of literature and research utilization for that problem.

Student Aid

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AID section of the *Graduate Bulletin*, the following awards typically have been available to graduate students in this program:

U.S. PUBLIC HEALTH SERVICE TRAINEESHIPS IN NURSING—Open to selected registered nurse, full-time students in nursing; stipend may be available plus tuition. Apply to Associate Director for Graduate Programs, School of Nursing.

NURSING (NURS)

- 400. PROFESSIONAL ROLE DEVELOPMENT (3)
- 401. CONCEPTS OF HEALTH (3)
- 402. HOLISTIC HEALTH (3)
- 415. (DF) COMMUNITY AND FAMILY HEALTH NURSING—CONCEPTS AND APPLICATIONS (4)
- 420. MENTAL HEALTH NURSING (4)
- 425. SCHOOL HEALTH NURSING (3)
- 430. ORGANIZATION AND ADMINISTRATION FOR THE NURSE MANAGER (3)
- 431. DATA MANAGEMENT FOR NURSE MANAGERS (3)
- 432. NURSING MANAGEMENT OF HUMAN RESOURCES (3)
- 433. MANAGING THE NURSE MANAGER (3)
- 440. TRAUMA/CRITICAL CARE NURSING (3)
- 445. TRAUMA NURSING (3)
- 450. REHABILITATION NURSING (3)

452. (BB H, WMNST) WOMEN'S HEALTH ISSUES (3)
455. NURSING RELATED TO COMPLEX HEALTH PATTERNS I (4)
457. INTRODUCTION TO COMPUTING AND NURSING INFORMATICS (3)
460. NURSING RELATED TO COMPLEX HEALTH PATTERNS II (4)
464. DYING AND DEATH (3)
495. NURSING STUDY IN SPECIALIZED SETTING (1–12)
496. INDEPENDENT STUDIES (1–18)
497. SPECIAL TOPICS (1–9)
499. FOREIGN STUDY—NURSING (1–9)
500. THE BASIS OF DISEASE PREVENTION AND HEALTH PROMOTION FOR OLDER ADULTS (3) This course helps prepare health professionals to apply selected health strategies to the promotion/prevention needs of older adults.
501. ISSUES IN NURSING AND HEALTH CARE (3) Analysis and evaluation of the health care system with emphasis on health policy and economic issues affecting nursing practice.
502. PHYSICAL ASSESSMENT ACROSS THE LIFE SPAN (3) Advanced assessment and diagnosis of physical, psychosocial, and developmental health throughout the life span in advanced practice.
503. PATHOPHYSIOLOGY FOR THE NURSE PRACTITIONER (3) Integration of advanced physiology, genetics, and pathophysiology as related to specific disease entities and alterations in functioning.
504. PHARMACOLOGIC THERAPY IN THE PRIMARY CARE SETTING (3) Use of pharmacologic therapies in advanced practice nursing.
506. QUALITATIVE NURSING RESEARCH (3) A research course with an emphasis on qualitative approaches and data collection methods.
507. QUANTITATIVE NURSING RESEARCH (3) Designs and statistical methods in nursing research. Prerequisite: NURS 506.
508. PERSPECTIVES IN POPULATION-BASED NURSING (3) Theories and strategies for promoting health in community aggregates with emphasis on vulnerable and underserved populations of diverse backgrounds.
509. ADVANCED PRACTICE NURSING IN THE RURAL COMMUNITY (2) This course will explore the issues, trends, and unique aspects of advanced practice nursing in a rural environment. Prerequisite: concurrent with last clinical practicum.
510. THEORETICAL FOUNDATIONS OF NURSING (3) Current conceptual and theoretical models in nursing including relationship to practice and research in development of nursing science.
518. ADULT/OLDER ADULT NURSING I: Concepts and Theories (3) Development of a conceptual framework for nursing practice with adults through analysis and synthesis of selected theories and research. Prerequisites: NURS 506, 510.
519. ADULT/OLDER ADULT NURSING II: ANALYSIS AND APPLICATION (3) Analysis and application of nursing interventions and models related to adult/older adult health. Prerequisites: NURS 507, 518.
521. ADVANCED NURSING PRACTICUM: ADULT HEALTH (3–6) Application of a model of nursing practice to a selected client population. Prerequisites: NURS 518, 519.
528. COMMUNITY-HEALTH NURSING I: CONCEPTS AND THEORIES (3) Development of a conceptual framework for nursing practice with communities through the analysis and synthesis of selected theories and research. Prerequisites: NURS 506, 508, 510.
529. COMMUNITY-HEALTH NURSING II: ANALYSIS AND APPLICATIONS (3) Analysis and application of models for program development, management, and evaluation in community health nursing. Prerequisite: NURS 507, 528.
531. ADVANCED NURSING PRACTICUM: COMMUNITY HEALTH (3–6) Application of a model of nursing practice to a selected client population. Prerequisites: NURS 528, 529.
550. TRANSCULTURAL HEALTH NURSING (3) Analysis of multicultural and ethnic influences on health, health beliefs and behavior, and nursing practice.
561. PHARMACOPHYSIOLOGICAL BASES FOR SPECIALIZED NURSING (4) Concepts of advanced pharmacology, genetics, developmental physiology, and pathophysiology applied to a specific population of patients. Prerequisites: NURS 510, 510, 511, and intermediate statistics.
562. NEONATAL NURSE PRACTITIONER PRACTICUM I (4) Assessment and management of a childbearing and newborn population under the supervision of preceptors in a variety of settings. Prerequisites: NURS 561, 565.
563. NEONATAL NURSE PRACTITIONER PRACTICUM II (6) Practicum in the management of a defined high-risk neonatal population under the supervision of preceptors. Prerequisite or concurrent: NURS 566.

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564. NEONATAL NURSE PRACTITIONER INTEGRATIVE PRACTICUM (8) The focus in this course is integration of specialty content and the NNP role, under the direction of preceptors. Prerequisite: all NNP specialization courses.
565. NURSING MANAGEMENT OF THE NORMAL CHILDBEARING FAMILY AND NEWBORN (4) Development of a conceptual framework for neonatal nurse practitioner (NNP) practice with childbearing families and their normal newborns. Prerequisite or concurrent: NURS 501, 510, 511, 561; AG 400, EDPSY 406, SOC 470, or STAT 460.
566. NURSING MANAGEMENT OF THE HIGH-RISK NEONATE (6) The focus of this course is knowledge underlying neonatal nurse practitioner nursing practice with the high-risk neonate and family. Prerequisite: NURS 562, 564.
570. EPISODIC ILLNESS AND HEALTH PROMOTION ACROSS THE LIFE SPAN (5) Health promotion and advanced nursing management of episodic illness in health individuals and families across the life span. Prerequisites: NURS 502, 503, 504. Concurrent: NURS 572.
571. CHRONIC ILLNESS AND HEALTH PROMOTION ACROSS THE LIFE SPAN (6) Health promotion and advanced nursing management of individuals and families across the life span experiencing chronic illness. Prerequisite: NURS 570. Prerequisite or concurrent: NURS 573.
572. FAMILY NURSE PRACTITIONER PRACTICUM I (5) Advanced practicum in assessment and management of healthy individuals and families across the life span experiencing episodic illness. Prerequisites: NURS 502, 503, 504. Concurrent: NURS 570.
573. FAMILY NURSE PRACTITIONER PRACTICUM II (6) Advanced practicum in primary care of individuals and families across the life span experiencing chronic illnesses. Prerequisites: NURS 570, 572. Concurrent: NURS 571.
574. FAMILY NURSE PRACTITIONER INTEGRATIVE PRACTICUM (8) Advanced nursing practicum in primary care of individuals and families across the life span integrating community/specialty content. Prerequisite: all FNP specialty courses.
590. COLLOQUIUM (1-3)
594. RESEARCH TOPICS (1-18)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)
598. SPECIAL TOPICS (1-9)

NUTRITION (NUTR)

JOHN A. MILNER, *In Charge of Intercollege Graduate Programs in Nutrition*
S126 Henderson Building
814-863-0772

Degrees Conferred: Ph.D., M.S., M.Ed. in Human Nutrition

The Graduate Faculty

Cheryl Achterberg, Ph.D. (Cornell) *Professor of Nutrition; Dean, Schreyer Honors College*
Namanjeet Ahluwalia, Ph.D. (Connecticut) *Assistant Professor of Nutrition*
Craig R. Baumrucker, Ph.D. (Purdue) *Professor of Animal Nutrition and Physiology*
John L. Beard, Ph.D. (Cornell) *Professor of Nutrition*
Cheston M. Berlin, Jr., M.D. (Harvard) *University Professor of Pediatrics and Pharmacology*
Leann Lipps Birch, Ph.D. (Michigan) *Professor and Head, Department of Human Development and Family Studies*
Dorothy A. Blair, Ph.D. (Cornell) *Assistant Professor of Nutrition*
J. Lynne Brown, Ph.D. (MIT) *Associate Professor of Food Science*
R. Elsworth Buskirk, Ph.D. (Minnesota) *Marie Underhill Noll Professor Emeritus of Human Performance*
James R. Connor, Ph.D. (California, Berkeley) *Associate Professor of Neuroscience and Anatomy*
Rebecca L. Corwin, Ph.D. (Chicago) *Assistant Professor of Nutrition*
Terry D. Etherton, Ph.D. (Minnesota) *Distinguished Professor of Animal Nutrition and Head, Department of Dairy and Animal Science*
Gary J. Fosmire, Ph.D. (California, Berkeley) *Associate Professor of Nutrition*
Michael H. Green, Ph.D. (California, Berkeley) *Professor of Nutrition*
Helen A. Guthrie, Ph.D. (Hawaii) *Professor Emeritus of Nutrition*
Jack Vanden Heuvel, Ph.D. (Wisconsin) *Assistant Professor of Veterinary Science*
Leonard S. Jefferson, Jr., Ph.D. (Vanderbilt) *Professor and Head, Department of Cellular and Molecular Physiology; Associate Dean for Research and Graduate Studies*

W. Larry Kenney, Ph.D. (Penn State) *Professor of Physiology and Kinesiology*
 Ronald S. Kensinger, Ph.D. (Florida) *Associate Professor of Dairy and Animal Science*
 John P. Kirwan, Ph.D. (Ball State) *Assistant Professor of Applied Physiology*
 Penny M. Kris-Etherton, Ph.D. (Minnesota) *Distinguished Professor of Nutrition*
 Roland M. Leach, Jr., Ph.D. (Cornell) *Professor of Poultry Science*
 Thomas A. Lloyd, Ph.D. (Harvard) *Professor of OB/GYN and Pharmacology*
 Audrey N. Maretzki, Ph.D. (Pittsburgh) *Professor of Food Science and Nutrition*
 Andrea M. Mastro, Ph.D. (Penn State) *Professor of Microbiology and Cell Biology*
 Edward W. Mills, Ph.D. (Purdue) *Associate Professor of Dairy and Animal Science*
 John A. Milner, Ph.D. (Cornell) *Professor and Head, Nutrition Department*
 Lawrence D. Muller, Ph.D. (Purdue) *Professor of Dairy Science*
 Paul Patterson, Ph.D. (Wisconsin, Madison) *Associate Professor of Poultry Science*
 Mary Frances Picciano, Ph.D. (Penn State) *Professor of Nutrition*
 Ruth Pike, Ph.D. (Chicago) *Professor Emeritus of Nutrition*
 Claudia K. Probart, Ph.D. (Oregon) *Associate Professor of Nutrition*
 C. Channa Reddy, Ph.D. (Indian Inst. of Science) *Distinguished Professor of Veterinary Science*
 Barbara J. Rolls, Ph.D. (Cambridge) *Helen A. Guthrie Chair and Professor of Nutrition*
 A. Catharine Ross, Ph.D. (Cornell) *Dorothy Foehr Huck Chair and Professor of Nutrition*
 Richard W. Scholz, Ph.D. (Purdue) *Professor of Veterinary Science*
 Barbara M. Shannon, Ph.D. (Purdue) *Distinguished Professor of Nutrition and Dean, College of Health and Human Development*
 Helen Smiciklas-Wright, Ph.D. (Penn State) *Professor of Nutrition*
 John E. Smith, Ph.D. (Nebraska) *Associate Professor of Nutrition*
 Lorraine M. Sordillo, Ph.D. (Louisiana) *Associate Professor of Veterinary Science*
 Donald B. Thompson, Ph.D. (Illinois) *Associate Professor and Head, Department of Food Science*
 Gabriella A. Varga, Ph.D. (Maryland) *Associate Professor of Animal Science*
 Regina Vasilatou-Younken, Ph.D. (Penn State) *Associate Professor of Poultry Science*
 Paul J. Wangness, Ph.D. (Iowa State) *Professor of Animal Science, and Senior Associate Dean, College of Agricultural Sciences*
 Nancy I. Williams, Sc.D. (Boston) *Assistant Professor of Kinesiology*
 Yu-Yan Yeh, Ph.D. (Illinois) *Associate Professor of Nutrition*

Graduates are prepared for careers in basic and applied research in nutrition and in college teaching. The course of study is planned to meet the professional objectives of the individual student. Students may emphasize nutrition science, applied human nutrition, applied animal nutrition, nutrition education, and nutrition in public health. Supporting courses are available in biochemistry, physiology, genetics, microbiology, biophysics, food science, education, health policy and administration, human development and family studies, anthropology, sociology, and psychology.

Current research emphasizes trace elements, vitamin A, lipid metabolism, nutrition and behavior, nutrition education strategies, and evaluation of dietary intake and nutritional status and nutrition policy.

Facilities include well-equipped nutrition science laboratories with animal facilities supervised by a University laboratory animal resource staff. The Nutrition Center and the program in nutrition education serve as a laboratory for students in community nutrition and nutrition education, and the Nutrition Clinic serves this function for those in clinical nutrition.

Admission Requirements

Scores from the Graduate Record Examination (GRE), or from the Medical College Admission Test (MCAT), are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *General Bulletin*.

College graduates with an undergraduate degree in nutrition, animal sciences, food science, dietetics, or a related biological or social science will be considered for admission. Applicants should have a minimum grade-point average of 3.00 (on a 4.00 scale), an acceptable score on the GRE (an average quantitative and verbal score above the fiftieth percentile), and three supporting recommendations. Exceptions may be made for students with special backgrounds, abilities, and interests. When openings are limited, the best-qualified candidates are given priority.

The basic expectations for admission from undergraduate studies include 6 credits in chemistry (organic and inorganic); 3 credits each in physiology, biochemistry, and nutrition; and physics, calculus, and analytical chemistry for some research areas in nutrition science and social science for public health and

community nutrition. Students with more than 9 credits of deficiency and a superior record may be admitted as provisional students until they qualify for consideration for regular degree status. Deficiencies are expected to be made up with a 3.00 grade-point average or better within the first two semesters.

Master's Degree Requirements

The graduate program in Nutrition offers the M.S. degree with an emphasis in nutrition science, applied human nutrition, nutrition education, or nutrition in public health.

The M.S. degree requires 30 credits of course work, including 6 credits in research (NUTRN 600). The M.Ed. degree requires 45 credits of course work, including 6 credits in a field of professional education. The M.S. and M.Ed. degrees with an emphasis on nutrition in public health include a 4-credit field experience (NUTR 555).

Doctoral Degree Requirements

Students are admitted on a provisional basis pending satisfactory completion of the candidacy examination designed to assess the student's potential and academic preparation for doctoral study. Candidacy examinations must be scheduled by students with a master's degree after they have completed 10 credits in doctoral work but before the end of the second semester following admission to the graduate program. The candidacy examination is administered and evaluated by the Graduate Candidacy Committee.

Communication and Language Requirement. Doctoral students must demonstrate competency in spoken English as judged by the program faculty and in technical writing by completion of ENGL 418 with a grade of B or better. Students also must complete satisfactorily 2 to 3 credits at the 400 or 500 level from any one of the following areas: (1) college teaching; (2) logic or philosophy of science; (3) foreign language; or (4) computer science. There are no specific course requirements; however, the academic program is developed by the student in consultation with his or her adviser to develop doctoral-level competence in nutrition and one or more supporting areas. Students are expected to participate in a colloquium each semester and enroll in a seminar on a regular basis.

Student Aid

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AID section of the *Graduate Bulletin*, the following awards typically have been available to graduate students in this program:

KRAFT FELLOWSHIPS IN NUTRITION EDUCATION—Two \$5,000 awards per year to master's or doctoral students.

ANIMAL NUTRITION (A NTR)

401. PHYSIOLOGY OF NUTRITION (3)

496. INDEPENDENT STUDIES (1–18)

497. SPECIAL TOPICS (1–9)

505. RUMINOLOGY (3) Physiological, biochemical, and microbiological activities occurring within the rumen and the relation of rumen function to animal response. Prerequisites: at least one course in each of the following areas: animal nutrition, physiology, microbiology, and biochemistry.

590. COLLOQUIUM (1–3)

NUTRITION (NUTR)

400. INTRODUCTION TO NUTRITION COUNSELING (1–3)

420. EXPERIMENTAL FOODS (4)

421. CULTURAL ASPECTS OF FOODS (3)

422. ADVANCED FOODS (3)

430. (S T S) GLOBAL FOOD STRATEGIES: PROBLEMS AND PROSPECTS FOR REDUCING WORLD HUNGER (3)

445. NUTRIENT METABOLISM I (3)

446. NUTRIENT METABOLISM II (3)

450. PRINCIPLES OF HUMAN NUTRITION (3)

451. NUTRITION THROUGHOUT THE LIFE CYCLE (3)

452. NUTRITIONAL ASPECTS OF DISEASE (3)

453. DIET IN DISEASE (3)

454. LABORATORY METHODS IN NUTRITION (3)

456. COMMUNITY NUTRITION (2)

490W. NUTRITION SEMINAR (3)

495. ADVANCED FIELD EXPERIENCE IN NUTRITION (1–6)

496. INDEPENDENT STUDIES (1–18)

497, 498. SPECIAL TOPICS (1–9)

NUTRITION (NUTRN)

506. (AN SC) RUMINOLOGY (3) Physiological, biochemical, and microbiological activities occurring within the rumen and the relation of rumen function to animal response. Prerequisites: at least one course in each of the following areas—animal nutrition, physiology, microbiology, and biochemistry.

511. MATERNAL AND INFANT NUTRITION (2) Physiological and psychosocial factors affecting human nutritional needs and feeding practices during the life-cycle stages of pregnancy, lactation, and infancy. Prerequisite: NUTR 451.

512. NUTRITION AND AGING (2) Consideration a physiological and psychosocial changes influencing nutritional status of the aged; nutrient requirements; nutrient-disease interactions; nutritional care of the elderly. Prerequisite: NUTR 452.

513. ATHEROSCLEROSIS AND NUTRITION (2) The etiology and pathophysiology of atherosclerotic cardiovascular disease, with emphasis on nutritionally related aspects. Prerequisite: NUTR 452.

514. (V SC) PROSTAGLANDINS AND LEUKOTRIENES (3) Biochemical, physiological, and nutritional aspects of arachidonic acid and related essential fatty acid metabolism. Structure-activity relationships of prostaglandins, prostacyclins, thromboxanes, and leukotrienes. Prerequisites: BIOCH 402 or 437.

515. MATHEMATICAL MODELING IN NUTRITION (2) Study of the theory and application of mathematical modeling of the tracer and tracee kinetics of nutrients and their metabolites in animals and humans. Prerequisites: MATH 140 or 141.

520. READINGS IN NUTRITION (0.5) Readings and reports of selected topics in nutrition.

521. NATIONAL NUTRITION POLICY (1) Description of major structures, factors, and issues in national nutrition policy. Implications for nutrition research and services.

530. PROBLEMS IN FOODS AND NUTRITION (1–6)

551. SEMINAR IN NUTRITION (1–6) Selected topics and recent advances in nutrition.

556. THE SURVEY METHOD IN FOODS AND NUTRITION (2) Study of survey techniques as a tool in the assay of food adequacy and nutritional status.

560. PLANNING AND EVALUATING NUTRITION PROGRAMS (3) Administration of public health nutrition programs, including community assessment program planning, implementation, and evaluation.

567. THE CHEMICAL SENSES (TASTE AND SMELL) (2) Physiology, psychophysics, and genetics of taste and smell. Relation between the chemical sense and nutrition. Taste and smell in special populations.

581. REGULATION OF NUTRIENT METABOLISM I (4) Integration of nutritional, biomedical, biochemical, physiological, and hormonal processes involved in carbohydrate, lipid, and protein metabolism. Prerequisite: B M B 101, NUTR 450.

582. REGULATION OF NUTRIENT METABOLISM II (3) Complementary to NUTRN 581 with an emphasis on metabolic roles of vitamin and mineral elements. Prerequisite: B M B 101, NUTR 450.

590. COLLOQUIUM (1–3)

596. INDIVIDUAL STUDIES (1–9)

597. SPECIAL TOPICS (1–9)

OPERATIONS RESEARCH (O R)

SUSAN H. XU, *Chair of the Committee on Operations Research*

335 Beam Building

814-863-0531

Degrees Conferred: Students electing this option through participating programs earn a degree with a dual title at both the Ph.D. and the M.S., M.A., or M.Eng. levels, i.e., Ph.D. in (graduate program name) and Operations Research, or M.S., M.A., or M.Eng. in (graduate program name) and Operations Research.

The Graduate Faculty

Charles E. Antle, Ph.D. (Oklahoma State) *Professor Emeritus of Statistics*

Anantaram Balakrishnan (Massachusetts) *Professor and Smeal Chair in Management Science and Information Systems*

Russell R. Barton, Ph.D. (Cornell) *Professor of Industrial Engineering*

Tom M. Cavalier, Ph.D. (Virginia Polytechnic) *Professor of Industrial Engineering*

M. Jeya Chandra, Ph.D. (Syracuse) *Professor of Industrial Engineering*

Kalyan Chatterjee, Ph.D. (Harvard) *Distinguished Professor of Management Science and Information Systems*

David P. Christy, Ph.D. (Georgia) *Associate Professor of Management Science and Information Systems*
 N. Edward Coulson, Ph.D. (California, San Diego) *Assistant Professor of Economics*
 E. Emory Ensore, Jr., Ph.D. (Penn State) *Professor of Industrial Engineering*
 Turgay Ertekin, Ph.D. (Penn State) *Professor of Petroleum and Natural Gas Engineering*
 Jill L. Findeis, Ph.D. (Washington State) *Associate Professor of Agricultural Economics*
 Duncan K. H. Fong, Ph.D. (Purdue) *Associate Professor of Management Science and Information Systems*
 Natarajan Gautam (University of North Carolina) *Assistant Professor of Industrial Engineering*
 Richard L. Gordon, Ph.D. (MIT) *Professor of Mineral Economics*
 Milton C. Hallberg, Ph.D. (Iowa State) *Professor of Agricultural Economics*
 Catherine Harmonosky, Ph.D. (Purdue) *Associate Professor of Industrial Engineering*
 Terry P. Harrison, Ph.D. (Tennessee) *Professor of Management Science and Information Systems*
 Jack C. Hayya, Ph.D. (UCLA) *Professor of Management Science and Information Systems*
 Paul H. Heinemann, Ph.D. (Florida) *Associate Professor of Agricultural Engineering*
 Michael P. Hottenstein, D.B.A. (Indiana) *Professor of Management*
 George B. Kleindorfer, Ph.D. (Carnegie Mellon) *Professor of Management Science and Information Systems*
 Joseph M. Lambert, Ph.D. (Purdue) *Associate Professor of Computer Science*
 Holly S. Lewis, Ph.D. (South Carolina) *Associate Professor of Management Science and Information Systems*
 Gary L. Lilien, D.E.S. (Columbia) *Distinguished Research Professor of Management Science and Information Systems*
 Stuart H. Mann, Ph.D. (Case Western Reserve) *Professor of Operations Research*
 Costas Marana (Princeton) *Assistant Professor of Chemical Engineering*
 John I. McCool, Ph.D. (Temple) *Associate Professor of Industrial Engineering*
 Wesley N. Musser, Ph.D. (California, Berkeley) *Professor of Agricultural Economics*
 Jan M. Mutmanský, Ph.D. (Penn State) *Professor of Mineral Engineering*
 J. Keith Ord, Ph.D. (London) *David H. McKinley Professor of Business Administration*
 Raja V. Ramani, Ph.D. (Penn State) P.E. *Professor of Mining Engineering*
 A. Ravindran (Berkeley) *Professor of Industrial Engineering*
 William B. Roush, Ph.D. (Oregon State) *Associate Professor of Poultry Science*
 James S. Shortle, Ph.D. (Iowa State) *Associate Professor of Agricultural Economics*
 Spiro Stefanou, Ph.D. (California State) *Associate Professor of Agricultural Economics*
 Joseph V. Terza, Ph.D. (Univ. of Pittsburg) *Associate Professor of Economics*
 Leonid N. Vaserstein, Ph.D. (Moscow State) *Professor of Mathematics*
 Jose A. Ventura, Ph.D. (Florida) *Professor of Industrial Engineering*
 Paul N. Walker, Ph.D. (Massachusetts) P.E. *Professor of Agricultural Engineering*
 Anthony V. Williams, Ph.D. (Michigan State) *Associate Professor of Geography*
 Susan H. Xu, Ph.D. (Rensselaer) *Associate Professor of Management Science and Information Systems*

The Operations Research dual-title degree program option is administered by an Operations Research committee, which is responsible for management of the program. The committee maintains program definition, identifies faculty and courses appropriate to the option, and recommends policy and procedures for its operation to the dean of the Graduate School. This dual-title degree program is offered as an option through graduate major programs in eight colleges. The option enables students from diverse graduate programs to attain and be identified with the tools, techniques, and methodology of operations research, while maintaining a close association with areas of application. Operations research is the analysis—usually involving mathematical treatment—of a process, problem, or operation to determine its purpose and effectiveness and to gain maximum efficiency. To pursue a dual-title degree under this program option the student must apply to the Graduate School and register through one of the following graduate major programs: Agricultural Economics, Agricultural Engineering, Business Administration, Civil Engineering, Computer Science, Economics, Educational Administration, Electrical Engineering, Entomology, Forest Resources, Geosciences, Geography, Industrial Engineering, Mathematics, Mechanical Engineering, Mineral Economics, Mining Engineering, Petroleum and Natural Gas Engineering, Poultry Science, or Statistics.

Admission Requirements

Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. Requirements listed here are in addition to general Graduate School requirements listed in the GENERAL INFORMATION section of the *Graduate Bulletin*.

For the M.S., M.A., M.Eng. dual-title degree in Operations Research, in addition to those prescribed by the graduate major program, prerequisites for acceptance to the program without deficiency include the following or their equivalent: MATH 140, 141, 220; CMPSC 101; and 3 credits of probability and statistics.

For the Ph.D. dual-title degree in Operations Research, in addition to those prescribed by the graduate major program, prerequisites for acceptance to the program without deficiency include the following or their equivalent: MATH 401, 436; CMPSC 101; and 3 credits of probability and statistics.

Degree Requirements

To qualify for a dual-title degree, students must satisfy the requirements of the graduate major programs in which they are enrolled, in addition to the minimum requirements, or their equivalent, in the Operations Research program. Students must enroll in OR 590 Colloquium for at least 1 credit in each year enrolled in the program and in residence.

For the M.S. or M.A. dual-title degree in Operations Research, the minimum requirements are: 6 credits in stochastic/statistical methods, including a minimum of 3 credits in each of the areas of statistical methods and stochastic processes; 6 credits in optimization, including a minimum of 3 credits in linear programming; 3 credits in computational methods; and 3 credits in applications/specialization. (Application courses are those that involve problem solving through the use of decision methods.) A minimum of 9 credits must be in the 500 series. Particular courses may satisfy both the graduate major program requirements and those in the Operations Research program.

A thesis may be required, the supervisor of which must be a member of the graduate faculty recommended by the chair of the program granting the degree and approved by the Operations Research committee as qualified to supervise thesis work in operations research. A paper or report may be written in lieu of the M.S. or M.A. thesis upon approval of the student's graduate major program. An M.Eng. student or a student selecting the paper or report must take an additional 6 credits in the Operations Research program. It is the prerogative of the graduate major program to assign these credits to one or more of the following categories: stochastic/statistical methods, optimization, computational methods, or applications.

The minimum requirements for the Ph.D. dual-title degree in Operations Research are: 9 credits in stochastic/statistical methods, including a minimum of 3 credits in each of the areas of statistical methods and stochastic processes; 9 credits in optimization, including a minimum of 3 credits in linear programming; 6 credits in computational methods, including a minimum of 3 credits in simulation; and 12 credits in applications/specialization. A minimum of 18 credits must be in the 500 series, and particular courses may satisfy both the graduate major program requirements and those in the Operations Research program.

A Ph.D. minor program in Operations Research is available for doctoral students who find it advantageous to include advanced quantitative methods of systems analysis in their programs of study and have been approved to do so by their doctoral committees. To qualify for a minor in Operations Research, students must satisfy the requirements of their graduate major programs, meet the same prerequisites as the M.S. dual-title degree, and meet the following minimum requirements: 6 credits in stochastic/statistical methods, including a minimum of 3 credits in each of the areas of statistical methods and stochastic processes; 6 credits in optimization; and 3 credits in computational methods. A minimum of 6 credits must be taken at the 500 level.

The doctoral committee for a Ph.D. dual-title degree student is recommended by the graduate major program granting the degree. The chair and at least two members of a doctoral committee must be members of the graduate faculty and approved by the Operations Research committee as qualified to supervise doctoral theses in operations research. The Operations Research committee is responsible for administering an examination in operations research that constitutes a portion of the comprehensive examination administered to the doctoral students in the program option, as well as to the candidate who chooses operations research as a minor field.

STOCHASTIC/STATISTICAL METHODS

Statistical Methods

MATH/STAT 414, 415, 418

IE 511

MS&IS 533

STAT 460, 501, 502, 503

ECON 501

AG EC/ECON 510, 511

Stochastic Processes

IE /MS&IS 516

PATHOBIOLOGY

I E 517

MATH/STAT 416, 516, 519

STAT 515

OPTIMIZATION

Linear Programming

I E 405 or MS&IS 451 or MATH 484

I E 505

AG EC 527

Nonlinear Programming

MS&IS 452

I E 521

Integer Programming

I E 510

Dynamic Programming

I E/MS&IS 519

Mathematical Programming

I E 512, 520

CMPSC/MATH 555

MS&IS 540, 550

COMPUTATIONAL METHODS

Numerical Methods

CMPSC/MATH 451, 455, 456, 550

Simulation Methods

I E 453 or MS&IS 432

I E 522

MSIS 532

APPLICATION/SPECIALIZATION

Includes courses in the above areas as well as courses in quality control, scheduling, inventory, queueing, decision analysis, game theory, logistics, expert systems, econometrics, forecasting, and others.

OPERATIONS RESEARCH (O R)

590. COLLOQUIUM (1-3)

PATHOBIOLOGY (PATHB)

LORRAINE M. SORDILLO, *Director of the Graduate Program in Pathobiology*

101 Henning Building

(814) 863-5786

Degrees Conferred: Ph.D., M.S.

The Graduate Faculty

Anthony E. Castro, D.V.M.; Ph.D. (Purdue) *Senior Research Associate in Veterinary Science*

Pamela H. Correll, Ph.D. (George Washington) *Assistant Professor of Veterinary Science*

Mary Lou Eskew, Ph.D. (Penn State) *Research Associate in Veterinary Science*

Frederick G. Ferguson, D.V.M., Ph.D. (Pennsylvania) *Professor of Veterinary Science*

Lester C. Griel, Jr., M.S., V.M.D. (Pennsylvania) *Professor of Veterinary Science*

Arthur L. Hattel, D.V.M. (Colorado) *Research Associate in Veterinary Science*

Andrew J. Henderson, Ph.D. (California, Riverside) *Assistant Professor of Veterinary Science*

Lawrence J. Hutchinson, D.V.M. (Cornell) *Professor of Veterinary Science*

Bhushan Jayarao, Ph.D. (Univ. of Vet. Sci., Budapest) *Assistant Professor of Veterinary Science*

Carol W. Maddox, Ph.D. (Penn State) *Research Associate in Veterinary Science*

Andrea M. Mastro, Ph.D. (Penn State) *Professor of Microbiology and Cell Biology*

V. Reddy Padala, Ph.D. (Indian Inst. of Sci.) *Senior Research Associate in Veterinary Science*

Robert Paulson, Ph.D. (California, San Francisco) *Assistant Professor of Veterinary Science*

Gary H. Perdew, Ph.D. (Oregon State) *Professor of Veterinary Science*

C. Channa Reddy, Ph.D. (Indian Inst. of Sci.) *Distinguished Professor of Veterinary Science*
 A. Catharine Ross, Ph.D. (Cornell) *Professor and Head of Veterinary Science*
 Richard W. Scholz, Ph.D. (Purdue) *Professor of Veterinary Science*
 Lorraine M. Sordillo, Ph.D. (Louisiana) *Associate Professor of Veterinary Science*
 Jack Vanden Heuval, Ph.D. (Wisconsin) *Assistant Professor of Veterinary Science*
 Daniel Weinstock, D.V.M., Ph.D. (Cornell) *Senior Research Associate in Veterinary Science*
 Richard A. Wilson, Ph.D. (Montana State) *Professor of Veterinary Science*
 Don M. Wojchowski, Ph.D. (Massachusetts) *Associate Professor of Veterinary Science*

The graduate program in Pathobiology is designed to provide flexibility in graduate work while providing opportunities to study immunology, microbiology, nutrition, biochemistry, virology, veterinary pathology, physiology, or toxicology, usually as related to problems seen in domestic animals and humans.

Graduate instruction is directed by graduate faculty members from the Department of Veterinary Science and related units including dairy and animal science, biochemistry, biology, biophysics, immunology, nutrition, physiology, zoology, and others. The Ph.D. program is designed for completion in three to four academic years. Doctoral candidates usually complete certain required courses and obtain laboratory experience before selecting an area of specialization and completing an original research problem, including the defense of the Ph.D. dissertation.

Facilities for departmental research include laboratories in the Agricultural Sciences and Industries Building, Henning Building, Poultry Disease Laboratory, Animal Diagnostic Laboratory, Centralized Biological Laboratory, and Environmental Resources Research Institute. Opportunities to utilize specialized research equipment exists in other related facilities. The University has an extensive, modern library. A large University Computer Center and consultation service are available.

Admission Requirements

Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Applicants with a 3.00 or better grade-point average (on a 4.00 scale) in undergraduate science courses and appropriate course backgrounds will be considered for admission. Applicants should have a baccalaureate degree in biological science or a degree as a graduate veterinarian or equivalent. Undergraduate preparation should include biology, chemistry, physics, mathematics through calculus, and preferably biostatistics and biochemistry.

Preference is given to students preparing for the Ph.D. degree, although a master's degree is obtained in some cases prior to the Ph.D., or as a final degree.

Master's Degree Requirements

A minimum of 30 graduate credits is required for the M.S. degree, of which 18 credits must be taken in 500- and 600-level courses.

Satisfactory completion of the following courses or their equivalent is required of all degree candidates: statistics, 3 credits; biochemistry or molecular and cell biology (usually chosen from B M B 400, 401, 402, 437, and BMBB 514), 6 credits; and pathobiology (V SC 520), 3 credits.

All graduate students are required to complete one semester of V SC 590 Colloquium each year as well as 8 credits from a list of courses.

Pathobiology requires no program-specific qualifying examinations, and there is no communication/language requirement for the M.S.

A thesis is required of all candidates for the M.S. degree.

Doctoral Degree Requirements

The doctor of philosophy degree places a strong emphasis on research. It is conferred in recognition of the capacity to carry out independent research and the attainment of a high level of scholarship. General requirements for the doctorate specify a minimum period of residence, the passing of candidacy, comprehensive and final oral examinations, and the writing of a satisfactory thesis. The particular combination of courses, seminars, individual study, and research that constitutes an individual student's program is arranged by the doctoral committee and should include the courses that have been designated in the Pathobiology graduate curriculum, subject to the general policies of the Graduate School.

The Graduate School requires no specified number of courses for the attainment of the doctorate. However, the department requires that all graduate students complete the course requirements outlined as

PETROLEUM AND NATURAL GAS ENGINEERING

above for the M.S. degree. A minimum grade-point average of 3.00 for work done at the University is required.

There are formal communications requirements for the Ph.D. degree in Pathobiology which are required by the Graduate School. The doctoral committee will assess the technical writing and oral communication skills of the candidate and may require that formal course work or other means to improve these skills be undertaken.

The graduate program requires that each graduate student have 3 credits in statistics. However, Ph.D. candidates are expected to have statistical skills equivalent to those learned in STAT 501 and 502. The candidacy examination committee and the doctoral committee will assess the student's competence in statistics and may require that additional course work be taken.

A candidacy examination is given to students entering the Ph.D. program and after they complete at least twelve hours of postbaccalaureate course work.

After being admitted to candidacy, each doctoral candidate is guided by a doctoral committee consisting of four or more members of the graduate faculty. At least one member and preferably two are from other departments. These committees are appointed through the Office of Graduate Student Programs, upon recommendation of the department head, after the student is admitted to candidacy.

Other Relevant Information

After a student has been admitted to graduate study in the department, an adviser will be appointed by the program director. This person may be a member of the eventual M.S. committee or someone else assigned the responsibility for directing the student's scheduling of course work. In the case of a doctoral candidate, the person may be a member of the eventual doctoral committee or someone else designated the responsibility for directing the student's scheduling of course work. The adviser is also responsible for initiating the scheduling of the candidacy examination.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

VETERINARY SCIENCE (V SC)

- 402. (ENT) BIOLOGY OF ANIMAL PARASITES (3)
- 405. LABORATORY ANIMAL SCIENCE (3)
- 407. DAIRY HERD HEALTH PROGRAMS (2)
- 420. GENERAL ANIMAL PATHOLOGY (3)
- 425. (PTYSC) PRINCIPLES OF AVIAN DISEASES (3)
- 435. (M C B/MICRB) MEDICAL VIROLOGY (2)
- 489. (BIOTC) ANIMAL CELL CULTURE METHODS (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)

514. (NUTRN) PROSTAGLANDINS AND LEUKOTRIENES (3) Biochemical, physiological, and nutritional aspects of arachidonic acid and related essential fatty acid metabolism. Structure-activity relationships of prostaglandins, prostacyclins, thromboxanes, and leukotrienes. Prerequisite: BIOCH 402 or BIOCH 437.

520. PATHOBIOLOGY (3) Mechanism of disease processes. Prerequisites: V SC 420; BIOCH 401 or 437.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-9)

597A. CYTOKINES (1) Overviews the role of cytokines in the pathology, treatment, and prevention of disease.

598. SPECIAL TOPICS (1-9)

PETROLEUM AND NATURAL GAS ENGINEERING (PNG E)

ABRAHAM S. GRADER, *In Charge of Graduate Programs in Petroleum and Natural Gas Engineering*

203 Hosler Building

814-865-5813

Degrees Conferred: Ph.D., M.S.

The Graduate Faculty

Michael A. Adewumi, Ph.D. (IIT) *Professor of Petroleum and Natural Gas Engineering*
 Turgay Ertekin, Ph.D. (Penn State) *Professor of Petroleum and Natural Gas Engineering*
 Abraham S. Grader, Ph.D. (Stanford) *Associate Professor of Petroleum and Natural Gas Engineering*
 Phillip M. Halleck, Ph.D. (Chicago) *Associate Professor of Petroleum and Natural Gas Engineering*
 Cem Sarica, Ph.D. (Tulsa) *Associate Professor of Petroleum and Natural Gas Engineering*
 Robert W. Watson, Ph.D. (Penn State) *Associate Professor of Petroleum and Natural Gas Engineering*

Areas of specialization include fluid dynamics in pipes, multiphase flow in porous media, reservoir engineering, transient pressure analysis, drilling, perforating and completion engineering, secondary migration, environmental issues, numerical reservoir simulation, rock mechanics, improved hydrocarbon recovery, coalbed methane.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are required for admission. A minimum GRE quantitative score of 700 is expected. At the discretion of the graduate committee of the program, a student may be admitted provisionally for graduate study without these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Students who expect to enter graduate study in this program with a degree in another major should present 6 credits in geology, 15 in engineering science, and credit for mathematics through integral calculus. A limited number of deficiencies may be made up after admission.

Students with a 3.00 junior/senior grade-point average (on a 4.00 scale) and with appropriate course backgrounds will be considered for admission. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

Degree Requirements

The general requirements for graduation are outlined in the bulletin. Specific credit requirements for the PNGE graduate program are available upon request. Graduate committees play an important role in formulating individual courses and research schedules. Certain closely related courses outside the department may be counted as petroleum and natural gas credits toward this degree. The communication and foreign language requirements for the Ph.D. degree may be satisfied by intermediate knowledge of one foreign language.

Other Relevant Information

Students in this program may elect the dual-title degree program option in Operations Research for the Ph.D. and M.S. degree. (See also Operations Research.)

Student Aid

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AID section of the *Graduate Bulletin*, some company fellowships have been available to graduate students in this program.

PETROLEUM AND NATURAL GAS (P N G)

- 405. ROCK AND FLUID PROPERTIES (2)
- 406. ROCK AND FLUID LABORATORY (1)
- 410. APPLIED RESERVOIR ENGINEERING (3)
- 420. APPLIED RESERVOIR ANALYSIS (2)
- 425. PRINCIPLES OF WELL TESTING AND EVALUATION (3)
- 430. RESERVOIR MODELING (3)
- 440W. FORMATION EVALUATION (3)
- 450. DRILLING DESIGN AND PRODUCTION ENGINEERING (3)
- 451. OIL WELL DRILLING LABORATORY (1)
- 475. PETROLEUM ENGINEERING DESIGN (3)
- 480. PRODUCTION PROCESS ENGINEERING (3)
- 482. PRODUCTION ENGINEERING LABORATORY (1)
- 485. SECONDARY RECOVERY ENGINEERING (2)
- 486. TERTIARY OIL RECOVERY METHODS (3)
- 493. ENGINEERING EVALUATION OF OIL AND GAS PROPERTIES (3)
- 494. THESIS (1-6)
- 497, 498. SPECIAL TOPICS (1-9)

PHARMACOLOGY

501. STEADY STATE FLOW IN POROUS MEDIA (3) The formulation and analytical solution of the problems of steady state fluid flow in porous media.
502. UNSTEADY FLOW IN POROUS MEDIA (3) The formulation and analytical solution of the transient fluid flow in porous media. Prerequisite: P N G 501.
503. RESERVOIR ENGINEERING PROBLEMS (3) Identification, formulation, and solution of advanced problems in reservoir engineering, e.g., cross-flow problems, dual porosity problems, etc. Prerequisite: P N G 502.
511. NUMERICAL SOLUTION OF THE PARTIAL DIFFERENTIAL EQUATIONS OF FLOW IN POROUS MEDIA (3) Differencing schemes for the partial differential equations of single-phase flow; application to flow of gas and mixing in porous media.
512. NUMERICAL RESERVOIR SIMULATION (3) Mathematical analysis of complex reservoir behavior and combination drives; numerical methods for the solution of behavior equations; recent developments. Prerequisite: P N G 410.
513. ADVANCED NUMERICAL RESERVOIR SIMULATION (3) Compositional simulation; history-matching theory; simulation of basic processes involving heat and mass transfer in porous media. Prerequisite: P N G 512.
514. OPTIMIZATION OF PETROLEUM RECOVERY PROCESSES (3) Optimum search methods, linear programming, nonlinear programming, dynamic programming, application to water flooding, depletion drive, steam injection, gas cycling, miscible displacement. Prerequisite: P N G 410.
515. ADVANCED OIL RECOVERY TECHNIQUES (3) Advanced oil recovery techniques including water flooding, in-situ combustion, steam injection, hot-water injection, and miscible-phase displacement.
518. DESIGN OF MISCIBLE RECOVERY PROJECTS (3) Theory and design of miscible methods of oil recovery, current field applications, including hydrocarbon, CO₂, micellar/polymer, alkaline, and inert gas. Prerequisite P N G 485.
519. DESIGN OF THERMAL RECOVERY PROJECTS (3) Suitability of reservoirs for thermal oil recovery; case histories; design of in-situ combustion and steamfloods; thermal stimulation; shale oil recovery. Prerequisite: P N G 515.
520. PHASE RELATIONS IN RESERVOIR ENGINEERING (3) Phase relations as applied to condensate and retrograde condensate reservoirs and to other problems in petroleum production.
530. NATURAL GAS ENGINEERING (1-3) Flow in producing or storage reservoirs; gas well testing; transmission systems; storage cycle; current developments. Prerequisite P N G 481.
550. ADVANCED ENGINEERING EVALUATION OF OIL- AND GAS-PRODUCING PROPERTIES (3) Selected topics of current research and development interest in formation evaluation, geophysical well logging, and production economics. Prerequisites: P N G 440, 493.
555. DRILLING OPTIMIZATION (3) Procedures for optimizing fluid properties, hydraulics, bit weight and selection. Balanced drilling conditions are stressed.
575. GAS LIFT DESIGN AND OPTIMIZATION (3) Design of continuous and intermittent gas lift systems; multiphase flow and inflow well performance.
576. PRODUCTION OPERATIONS (3) Exploration of recent practical and theoretical developments in well logging, fracture stimulation, and sand control.
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)
598. SPECIAL TOPICS (1-9)

NOTE: Courses in the use of X-ray diffraction, electron microscopy, and spectroscopy in petroleum and natural gas studies are listed under Materials Science (under "Other Courses and Options Carrying Graduate Credit" at the back of this bulletin).

PHARMACOLOGY (PHARM)

ELLIOT S. VESELL, *Chair of the Department*
The Milton S. Hershey Medical Center
Hershey, PA 17033
717-531-8285

Degrees Conferred: Ph.D., M.S., M.D./Ph.D. M.B.A./Ph.D.

The Graduate Faculty

Helen A. Baghdoyan, Ph.D. (Connecticut) *Associate Professor of Pharmacology and Anesthesia*

Cheston M. Berlin, Jr., M.D. (Harvard) *University Professor of Pediatrics and Professor of Pharmacology*

Melvin L. Billingsley, Ph.D. (George Washington) *Professor of Pharmacology*

Keith K. Burkhardt, M.D. (Medical College of Pennsylvania) *Associate Professor of Pharmacology and Medicine*

Victor A. Canfield, Ph.D. (California) *Assistant Professor of Pharmacology*

John D. Connor, Ph.D. (Phila. Col. Pharmacy and Science) *Professor of Pharmacology*

John Ellis, Ph.D. (Rochester) *Associate Professor of Pharmacology and Psychiatry*

Thomas Frielle, Ph.D. (Pittsburgh, School of Medicine) *Assistant Professor of Pharmacology*

Frank E. Greene, Ph.D. (Florida) *Associate Professor of Pharmacology*

Byron C. Jones, Ph.D. (Arizona) *Associate Professor of Biobehavioral Health and Pharmacology*

Mark Kester, Ph.D. (SUNY, Buffalo) *Associate Professor of Pharmacology*

Joan M. Lakoski, Ph.D. (Iowa) *Associate Professor of Pharmacology and Anesthesia*

Robert Levensen, Ph.D. (SUNY, Stony Brook) *Professor of Pharmacology*

Thomas A. Lloyd, Ph.D. (Harvard) *Professor of Obstetrics/Gynecology and Pharmacology*

Kathleen M. Mulder, Ph.D. (SUNY, Buffalo) *Associate Professor of Pharmacology*

Yuk-Chow Ng, Ph.D. (Michigan State) *Associate Professor of Pharmacology*

Anthony E. Pegg, Ph.D. (Cambridge) *Evan Pugh Professor of Physiology and Professor of Pharmacology*

Pondichery G. Satyaswaroop, Ph.D. (Bombay) *Professor of Obstetrics/Gynecology and Pharmacology*

Walter B. Severs, Ph.D. (Pittsburgh) *Professor of Pharmacology*

Joan Y. Summy-Long, Ph.D. (Penn State) *Professor of Pharmacology*

Elliot S. Vesell, M.D. (Harvard) *Evan Pugh Professor of Pharmacology and Professor of Genetics, and Medicine*

The graduate studies program in Pharmacology is designed to give qualified students a combination of didactic instruction, informal direction, and laboratory experience that will enable them to obtain a firm foundation in the principles, methods, and contributions of pharmacology (defined broadly as the science of the multiple aspects of the interaction of chemical agents with biological systems). With this preparation, graduates of the program should be capable of designing and executing high-quality independent research, and of assuming positions of responsibility within the pharmacologic community.

The department offers studies in the general areas of drug metabolism, molecular pharmacology, endocrine pharmacology, neuropharmacology, cardiovascular-renal pharmacology, and clinical pharmacology. Primary emphasis is placed on the molecular mechanism by which drugs act in the body and by which the body transforms drugs. The department also offers a concurrent degree program resulting in a combined M.B.A./Ph.D. Consult department for details.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are required for admission. At the discretion of the graduate program, a student may be admitted provisionally for graduate study without these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

A bachelor's degree reflecting a reasonable background in zoology or biology, mathematics, and chemistry is required. Reading knowledge of one or two foreign languages is recommended. Students with a minimum junior/senior grade-point average of 3.00 and with appropriate course backgrounds will be considered for admission. Two letters of recommendation, a curriculum vitae, and a description of career goals are required. Students are not usually accepted into the graduate program unless they are preparing for the doctoral degree.

Master's Degree Requirements

A minimum of 30 credits as specified by the Graduate School are required. Candidates must submit a thesis based on original laboratory observations. A specified core curriculum includes the following courses: BCHEM 502; NEURO 520; CMBIO 540; PHARM 501, 502, 503, 504, 590; IBIOS 597. Candidates must defend their theses to the satisfaction of the graduate faculty (two-thirds favorable vote).

Doctoral Degree Requirements

Students will demonstrate skills in one of the following areas of communications: computer language, biostatistics; the department also requires competency in written and oral English. A specified core

PHILOSOPHY

curriculum includes the following courses: BCHEM 502; CMBIO 540, 518; NEURO 520; IBIOS 597A; PHARM 501, 502, 503, 504, 590, 596 (experience in three different laboratories), and two electives for credit in specialized areas of pharmacology or related disciplines.

Candidates for the combined M.D./Ph.D. programs must apply to and be accepted by the medical school before they can be considered for the combined program.

Candidates for the M.B.A./Ph.D. program must first apply and be accepted by the doctoral program before being considered for the M.B.A.

Other Relevant Information

Each new graduate student is assigned an adviser *pro tem* who will serve as a general counselor. Master's candidates have three months from initial registration to form an agreement with a member of the graduate faculty who will supervise their laboratory work. Doctoral candidates can take as much as a year to form this agreement.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

PHARMACOLOGY (PHARM)

501. PHARMACOLOGY (4) Lectures, discussions, and laboratory study of the mechanism of drug action in biological systems.

502. PHARMACOLOGY (4) Continuation of PHARM 501.

503. MOLECULAR PHARMACOLOGY I (4) Pharmacotherapeutics and integrated studies of medicinals at the molecular level. Prerequisite: PHARM 502.

504. MOLECULAR PHARMACOLOGY II (4) Continuation of PHARM 503. Prerequisites: PHARM 502, 503.

505. PHARMACOKINETICS (2) Quantitation of the time courses of absorption, distribution, metabolism, and excretion of drugs in the intact organism. Prerequisite: PHARM 501 or 502 or 520.

510. NEURAL SUBSTRATES FOR DRUG ACTION (1) Study of nerve function in specific brain regions especially relevant to drug action.

515. HUMAN GENETICS (2) Seminar-type presentations by students and staff on fundamental problems and current topics in human genetics.

520. PRINCIPLES OF DRUG ACTION (2) Detailed analysis of basic parameters governing drug actions.

540. PHARMACOGENETICS (2) Study of human responses to individual drugs.

541. (CMBIO) CELLULAR COMMUNICATION (2) This course explores the cellular and molecular basis of signal generation and information transduction in cells. Prerequisites: BCHEM 502, 505, CMBIO 540.

550. (NEURO) NEUROPHARMACOLOGY (3) An in-depth discussion of the mechanism and pharmacokinetics of various neuroactive drugs. Prerequisite: NEURO 510 OR PSIO 510.

571. TECHNIQUES IN PHARMACOLOGICAL RESEARCH (2) Classes will be comprised of lectures by the faculty of the Department of Pharmacology, followed by working demonstrations of the techniques.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

PHILOSOPHY (PHIL)

JOHN J. STUHR, *Head of the Department*

240 Sparks Building

814-865-6397

Degrees Conferred: Ph.D., M.A.

The Graduate Faculty

Douglas R. Anderson, Ph.D. (Penn State) *Associate Professor of Philosophy*

Priscilla N. Cohn, Ph.D. (Bryn Mawr) *Professor of Philosophy*

Vincent M. Colapietro, Ph.D. (University of Toronto) *Professor of Philosophy*

Daniel W. Conway, Ph.D. (California, San Diego) *Professor of Philosophy*

Véronique M. Fóti, Ph.D. (Boston College) *Associate Professor of Philosophy*

Robert E. Ginsberg, Ph.D. (Pennsylvania) *Professor of Philosophy*
 Emily R. Grosholz, Ph.D. (Yale) *Professor of Philosophy*
 Irene E. Harvey, Ph.D. (York) *Associate Professor of Philosophy*
 Dale Jacquette, Ph.D. (Brown) *Professor of Philosophy*
 Pierre Kerszberg, Ph.D. (Brussels) *Professor of Philosophy*
 Richard A. Lee, Jr., Ph.D. (Jagiellonian University, New School for Social Research) *Assistant Professor of Philosophy*
 Alphonso F. Lingis, Ph.D. (Louvain) *Professor of Philosophy*
 Carl Mitcham, Ph.D. (Fordham) *Professor of Philosophy and Science, Technology, and Society*
 Evelyn B. Pluhar, Ph.D. (Michigan) *Professor of Philosophy*
 Robert G. Price, Ph.D. (Yale) *Associate Professor of Philosophy*
 John E. Russon, Ph.D. (University of Toronto) *Assistant Professor of Philosophy*
 John Sallis, Ph.D. (Tulane) *Liberal Arts Professor of Philosophy*
 Susan M. Schoenbohm, Ph.D. (Vanderbilt University) *Senior Lecturer in Philosophy and Women's Studies*
 Charles E. Scott, Ph.D. (Yale) *Edwin Erle Sparks Professor of Philosophy*
 John J. Stuhr, Ph.D. (Vanderbilt) *Professor of Philosophy*

Graduate education in the Penn State Department of Philosophy is characterized by a focus on, and commitment to, the history of philosophy, conceived as a basis for study in diverse areas of special interest. In addition, the graduate program includes special emphases on both contemporary European American philosophy (including transcendentalism, semiotics, pragmatism, and contemporary cultural issues). In addition, all students' programs are arranged to facilitate preparation in the systematic fields of epistemology, philosophy of science, and mathematical logic and there is a provision for directed research, collaboration, and in-depth consultation by students with member of the faculty.

Interdisciplinary study is also possible across the humanities, the social sciences, the arts, the natural sciences, and interdisciplinary programs such as Women's Studies, Classics and Ancient Mediterranean Studies, and Science Technology, and Society. There are doctoral minors are available in social thought and in literary theory, criticism, and aesthetics, and joint programs with the Department of Mathematics in sciences. Study abroad is possible as well, through exchange programs or individual arrangements with leading departments of philosophy.

Admission Requirements

Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Undergraduate preparation is advisable.

Students with a 3.00 junior/senior grade-point average (on a 4.00 scale) and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests. Apply by January 1.

Degree Requirements

The department may waive the requirement of a thesis for an M.A. candidate. The foreign language requirement for the Ph.D. degree is satisfied by passing department translation examinations in two languages other than English, and by completing a course in philosophy in one of the these languages. The logic requirement for the Ph.D. degree is satisfied by passing a department logic examination.

Student Aid

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AID section of the *Graduate Bulletin*, the following awards typically have been available to graduate students in this program:

EDWIN ERLE SPARKS FELLOWSHIPS IN THE HUMANITIES (8)—Available to beginning and continuing graduate students in one of the following graduate programs: Comparative Literature, English, French, German, History, Linguistics, Philosophy, Spanish, and Speech Communication; stipend \$12,260 plus waiver of tuition. Apply to department before January 1.

PHILOSOPHY (PHIL)

401. (AM ST) AMERICAN PHILOSOPHY (3)
402. EUROPEAN PHILOSOPHY (3)
403. ENVIRONMENTAL ETHICS (3)
405. PHILOSOPHY OF LAW (3)
406. BUSINESS ETHICS (3)
407. (S T S) TECHNOLOGY AND HUMAN VALUES (3)
- 408.(DE) SOCIAL AND POLITICAL PHILOSOPHY (3)
- 408W. SOCIAL AND POLITICAL PHILOSOPHY (3)
409. AESTHETICS (3)
410. PHILOSOPHY OF SCIENCE (3)
412. PHILOSOPHICAL LOGIC (3)
413. PHILOSOPHY OF LITERATURE (3)
415. PHILOSOPHY OF EDUCATION (3)
416. PHILOSOPHY OF SOCIAL SCIENCE (3)
417. PHILOSOPHY OF MATHEMATICS (3)
418. ETHICS (3)
- 418W. ETHICS (3)
420. PHILOSOPHY OF ECONOMICS (3)
422. PHILOSOPHY OF HISTORY (3)
423. PHILOSOPHY, MEDIA, AND SOCIETY (3)
424. PHILOSOPHY OF RELIGION (3)
425. EPISTEMOLOGY (3)
- 425W. EPISTEMOLOGY (3)
426. METAPHYSICS (3 per semester, maximum of 6)
- 426W. METAPHYSICS (3 per semester, maximum of 6)
427. PHILOSOPHY OF MIND (3)
429. PHILOSOPHY OF LANGUAGE (3)
431. PHILOSOPHY OF AGRICULTURE (3)
432. (S T S) MEDICAL AND HEALTH CARE ETHICS (3)
433. (S T S) ETHICS IN SCIENCE AND ENGINEERING (3)
435. (S T S) THE INTERRELATION OF SCIENCE, PHILOSOPHY, AND RELIGION (3)
437. WORLD PHILOSOPHIES AND CULTURES (3)
438. FEMINIST PHILOSOPHY (3 per semester, maximum of 6)
453. TOPICS IN ANCIENT PHILOSOPHY (3 per semester, maximum 6)
454. TOPIC IN MEDIEVAL PHILOSOPHY (3)
455. TOPICS IN MODERN PHILOSOPHY (3 per semester, maximum 6)
456. TOPICS IN 19TH CENTURY PHILOSOPHY (3 per semester, maximum 6)
457. TOPICS IN 20TH CENTURY PHILOSOPHY (3 per semester, maximum 6)
458. TOPICS IN CONTEMPORARY PHILOSOPHY (3 per semester, maximum 6)
461. PLATO (3 per semester, maximum of 6)
462. ARISTOTLE (3 per semester, maximum of 6)
464. AUGUSTINE (3 per semester, maximum of 6)
465. AQUINAS (3 per semester, maximum of 6)
470. RATIONALISM (3 per semester, maximum of 6)
471. EMPIRICISM (3 per semester, maximum of 6)
472. ENLIGHTENMENT (3 per semester, maximum of 6)
473. GERMAN IDEALISM (3 per semester, maximum of 6)
474. KANT (3 per semester, maximum of 6)
475. FICHTE AND SCHELLING (3 per semester, maximum of 6)
476. HEGEL (3 per semester, maximum of 6)
477. KIERKEGAARD (3 per semester, maximum of 6)
479. CRITICAL THEORY (3 per semester, maximum of 6)
480. MARX (3 per semester, maximum of 6)
481. NIETZSCHE (3 per semester, maximum of 6)
482. PEIRCE (3 per semester, maximum of 6)
483. JAMES (3 per semester, maximum of 6)
484. HUSSERL (3 per semester, maximum of 6)

485. HEIDEGGER (3 per semester, maximum of 6)
486. WITTGENSTEIN (3 per semester, maximum of 6)
487. ANALYTIC PHILOSOPHY (3 per semester, maximum of 6)
488. POST-STRUCTURALISM (3 per semester, maximum of 6)
490. DEWEY (3 per semester, maximum of 6)
491. MERLEAU-PONTY (3 per semester, maximum of 6)
492. FOUCAULT (3 per semester, maximum of 6)
493. PHENOMENOLOGY AND HERMENEUTICS (3 per semester, maximum of 6)
494. RESEARCH PROJECT (1–12)
496. INDEPENDENT STUDIES (1–18)
497. SPECIAL TOPICS (1–9)
499. FOREIGN STUDY—PHILOSOPHY (1–12)
500. ETHICS: HISTORIC AND SYSTEMATIC (3 per semester, maximum of 6) Critical study of some problem of ethical theory, or of some period in the history of ethics.
504. SOCIAL AND POLITICAL PHILOSOPHY (3 per semester, maximum of 6) Critical study of basic problems in their historical and functional setting.
509. SEMINAR IN CONTEMPORARY PHILOSOPHY (3 per semester, maximum of 6) People and movements in twentieth-century philosophy.
512. ADVANCED TOPICS IN PHILOSOPHY OF SCIENCE (3 per semester, maximum of 6) Crucial problems in the theory of science and scientific method.
513. (B A, PSY) PRINCIPLES AND METHODS OF EMPIRICAL SCIENCE (3) Scientific methodologies and their presuppositions, with special emphasis on behavioral and social science. Prerequisite: doctoral candidacy in B A/PSY or graduate status in PHIL.
514. NINETEENTH-CENTURY PHILOSOPHY (3 per semester, maximum of 6) Study of a philosopher or philosophical movement of the nineteenth century.
516. SEMINAR IN AESTHETICS (3 per semester, maximum of 6) Problems and theories in the nature of art.
526. SEMINAR IN METAPHYSICS (3 per semester, maximum of 6) Formulation and analysis of metaphysical problems in the various fields of philosophy.
550. SEMINAR IN PLATO (3 per semester, maximum of 6) Analysis of a major Platonic dialogue.
551. SEMINAR IN ARISTOTLE (3 per semester, maximum of 6) Analysis of a major Aristotelian treatise.
560. SEMINAR IN MEDIEVAL PHILOSOPHY (3 per semester, maximum of 6) Study of the works of a leading thinker of the Middle Ages, such as Augustine, Anselm, Aquinas, or Ockham.
570. SEMINAR IN CONTINENTAL RATIONALISM (3 per semester, maximum of 6) Topics in continental rationalism. At certain points, the interpretations will refer to the Latin and French originals.
571. SEMINAR IN BRITISH EMPIRICISM (3 per semester, maximum of 6) Seminar devoted to a major figure or topic in the British tradition from Bacon to Mill.
572. SEMINAR IN KANT (3 per semester, maximum of 6) Aspects of Kant's philosophy. At certain points, the interpretations will refer to the German original.
573. SEMINAR IN HEGEL (3 per semester, maximum of 6) Study of some Hegelian text; relevant scholarship and criticism. At certain points, the interpretations will refer to the German original.
580. PHENOMENOLOGY (3 per semester, maximum of 6) A critical study of one or more thinkers, ideas, or movements in modern phenomenology.
581. HERMENEUTICS (3 per semester, maximum of 6) Hermeneutic philosophy and aspects of its methodological significance for human studies, philology, history, sociology and psychology, and philosophy of science.
582. CONTEMPORARY EUROPEAN PHILOSOPHY (3 per semester, maximum of 6) Husserl's phenomenology and Heidegger's existence philosophy; structuralist and critical Marxism; Gadamer and hermeneutics; Derrida and metaphysical deconstruction.
583. ANGLO-AMERICAN PHILOSOPHY (3 per semester, maximum of 6) The methods of contemporary philosophical analysis. Readings from Russell, Quine, Wittgenstein, Austin, Strawson, and related writers.
590. COLLOQUIUM (1–3)
594. RESEARCH TECHNIQUE (1) A course utilizing research sources and techniques relevant to philosophical studies. Taken in the first semester of graduate study.
596. INDIVIDUAL STUDIES (1–9)
597. SPECIAL TOPICS (1–9)

PHYSICS (PHYS)

JAYANTH R. BANAVAR, *Acting Head of the Department*
104 Davey Laboratory
814-865-7533

Degrees Conferred: Ph.D., D.Ed., M.S., M.Ed.

The Graduate Faculty

Abhay V. Ashtekar, Ph.D. (Chicago) *Eberly Professor of Physics*
Jayanth R. Banavar, Ph.D. (Pittsburgh) *Professor of Physics*
James J. Beatty, Ph.D. (Chicago) *Associate Professor of Physics, and Astronomy and Astrophysics*
Moses H. W. Chan, Ph.D., (Cornell) *Evan Pugh Professor of Physics*
Milton W. Cole, Ph.D. (Chicago) *Professor of Physics*
John C. Collins, Ph.D. (Cambridge) *Professor of Physics*
Robert W. Collins, Ph.D. (Harvard) *Professor of Physics and Materials Research*
Stephane Coutu, Ph.D. (CalTech) *Assistant Professor of Physics*
Vincent H. Crespi, Ph.D. (California, Berkeley) *Assistant Professor of Physics*
James P. Crawford, Ph.D. (Colorado) *Associate Professor of Physics*
Paul H. Cutler, Ph.D. (Penn State) *Emeritus Professor of Physics*
Renee D. Diehl, Ph.D. (Washington) *Professor of Physics*
Wolfgang E. Ernst, Dr.rer.Nat. (Hannover) *Professor of Physics*
Norman Freed, Ph.D. (Case Western Reserve) *Professor of Physics*
Gabriela I. Gonzalez, Ph.D. (Syracuse) *Assistant Professor of Physics*
Thomas J. Gramila, Ph.D. (Cornell) *Assistant Professor of Physics*
Murat Günaydin, Ph.D. (Yale) *Professor of Physics*
M. Abul Hasan, Ph.D. (Lehigh) *Associate Professor of Physics*
Steven F. Heppelmann, Ph.D. (Minnesota) *Associate Professor of Physics*
Roger M. Herman, Ph.D. (Yale) *Professor of Physics*
Yong Baek Kim, Ph.D. (MIT) *Assistant Professor of Physics*
Qi Li, Ph.D. (Peking) *Assistant Professor of Physics*
Ying Liu, Ph.D. (Minnesota) *Assistant Professor of Physics*
Julian D. Maynard, Ph.D. (Princeton) *Distinguished Professor of Physics*
Nicholas M. Miskovsky, Ph.D. (Penn State) *Professor of Physics*
Benedict Y. Oh, Ph.D. (Wisconsin) *Professor of Physics*
Jay S. Patel, Ph.D. (SUNY, Stony Brook) *Professor of Physics, Electrical Engineering, and Materials Research*
Lawrence J. Pilione, Ph.D. (Penn State) *Professor of Physics*
Shyamoli Chaudhuri Plassmann, Ph.D. (Cornell) *Assistant Professor of Physics*
Jorge A. Pullin, Ph.D. (Istituto Balserio) *Associate Professor of Physics*
Richard W. Robinett, Ph.D. (Minnesota) *Associate Professor of Physics*
Nitin Samarth, Ph.D. (Purdue) *Associate Professor of Physics*
Gerald A. Smith, Ph.D. (Yale) *Professor of Physics*
Lee Smolin, Ph.D. (Harvard) *Professor of Physics*
Paul E. Sokol, Ph.D. (Ohio) *Professor of Physics*
Mark Strikman, Ph.D. (Leningrad) *Professor of Physics*
William S. Toothacker, Ph.D. (Michigan) *Professor of Physics*
Brian L. J. Weiner, Ph.D. (Leicester) *Associate Professor of Physics*
James J. Whitmore, Ph.D. (Illinois) *Professor of Physics*
Roy F. Willis, Ph.D. (Cambridge) *Professor of Physics*
Xiaoxing Xi, Ph.D. (Peking) *Assistant Professor of Physics*
John A. Yeazell, Ph.D. (Rochester) *Assistant Professor of Physics*

Graduate instruction and research opportunities are available in atomic and molecular physics, laser physics, experimental and theoretical condensed matter and materials physics, surface physics, low-temperature physics, statistical physics, acoustics, nuclear physics, experimental and theoretical particle physics, quantum field theory, general relativity, cosmology and relativistic astrophysics and quantum gravity. Work in some areas is conducted in cooperation with the Materials Research Institute, the Applied Research Laboratory, and other interdisciplinary research facilities. Thesis research toward the applied M.S. degree and the applied option of the Ph.D. degree is often carried out in one of those laboratories.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are required for admission. Requirements listed here are in addition to general Graduate School Requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

A bachelor's degree in physics or an allied field is required for admission to the M.S., D.Ed., and Ph.D. programs. Students with a 2.50 or higher junior/senior grade-point average (on a 4.00 scale) in physics and mathematics will be considered, and the best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests. Exceptions may also be made for applicants for doctoral programs who have completed master's degrees at other institutions.

Admission and study programs for the M.Ed. degree are handled on an individual basis.

Master's Degree Requirements

Standard M.S. program: Required courses include PHYS 530, 557, 559 (2 credits), 561, or 410. There are two options. **Thesis option:** The thesis must be based on at least 6 credits of PHYS 600 and must conform to Graduate School regulations. **Nonthesis option:** An additional 6 credits of 500-level physics courses beyond the required ones must be taken, and a short paper must be submitted to, and accepted by, the department. There is no degree examination for either option.

M.S. program in applied physics: This program has prerequisites of junior/senior level courses in electricity and magnetism, mechanics, electronics, thermodynamics, optics, solid-state physics, and computer programming. Required courses include advanced courses in electricity and magnetism and electronics, a 1-credit graduate laboratory course, a seminar series, and a course in quantum mechanics. In addition to these, two courses must be chosen from the areas of semiconductors and devices, surfaces and thin films, advanced optics, and acoustics; and at least two courses in the areas of properties of materials, laser and optoelectronics, space science, metallurgy, polymers, energy conservation, plasmas or fuel science, and atomic or molecular physics. Thesis research will start no later than the second semester and will be reported in a conventional master's thesis.

M.Ed. program: At least 18 credits in physics are required, of which up to 6 credits may be for research. Six additional nonresearch science credits (which may be in physics) and a 6-credit minor in a field of professional education also must be included. A thesis or term paper must be submitted and accepted by the department.

Doctoral Degree Requirements

Ph.D. program: Required courses include PHYS 517, 525, 530, 557, 558, 559 (2 credits), 561, 562, and a first-year seminar series. Courses required beyond these depend on the Ph.D. option. Those who choose the standard option take at least four additional 3-credit, 500-level physics courses. Those who choose the applied physics option take at least four additional courses of an applied nature selected from a list which will be provided by the physics department on request.

A candidacy examination is given at the end of the first year, a comprehensive examination approximately two years after the candidacy examination, and a final thesis defense takes place after the completion of the thesis. There is no departmental foreign language requirement, although a reading knowledge of one foreign language may be needed in some areas of research.

D.Ed. program: The requirements and procedures are the same as those for the Ph.D. program except for the following changes. Only two 500-level physics courses are required after the first ten courses listed above. An educational minor of at least 15 credits is required. A total of 90 credits must be earned in graduate school, at least 30 in residence. The thesis must be based on a minimum of 15 research credits.

Student Aid

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AID section of the *Graduate Bulletin*, the following awards typically have been available to graduate students in this program:

HOMER F. BRADDOCK GRADUATE FELLOWSHIPS—Available to exceptional Ph.D. candidates in several departments of the Eberly College of Science. They carry stipends of \$3,500 to \$7,500 per year for each of the first three years.

WHEELER P. DAVEY MEMORIAL FELLOWSHIPS—Carry stipend of variable amount and are available to a limited number of qualified graduate students in the Eberly College of Science.

DAVID C. DUNCAN GRADUATE FELLOWSHIPS—Available to first- and second-year graduate students in physics and carry a stipend of approximately \$2,000 per year for each of the first two years.

THE NELLIE AND OSCAR L. ROBERTS FELLOWSHIPS—Available to graduate students majoring in the physical sciences and in biochemistry and molecular biology. Each award is for \$4,000 per year for one or two years.

PHYSICS (PHYS)

- 400. INTERMEDIATE ELECTRICITY AND MAGNETISM I (3)
- 401. INTERMEDIATE ELECTRICITY AND MAGNETISM II (3)
- 402. ELECTRONICS FOR SCIENTISTS (4)
- 406. SUBATOMIC PHYSICS (3)
- 410. INTRODUCTION TO QUANTUM MECHANICS I (4)
- 411. INTRODUCTION TO QUANTUM MECHANICS II (3)
- 412. SOLID STATE PHYSICS I (3)
- 413. SOLID STATE PHYSICS II (3)
- 419. (MATH) THEORETICAL MECHANICS (3)
- 420. THERMAL PHYSICS (3)
- 443. INTERMEDIATE ACOUSTICS (3)
- 444. TOPICS IN CONTEMPORARY PHYSICS (2)
- 457, 457W. EXPERIMENTAL PHYSICS (1-3 per semester)
- 458. INTERMEDIATE OPTICS (4)
- 461. (MATH) THEORETICAL MECHANICS (3)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
- 499. FOREIGN STUDIES (1-12)

510. GENERAL RELATIVITY I (3) Foundations of general relativity, elements of differential geometry, Einstein's equation, Newtonian limit, gravity waves, Friedmann cosmologies and Schwarzschild solution. Prerequisites: PHYS 557.

511. TOPICS IN GENERAL RELATIVITY (3) Selected topics from: Cauchy problem, Hamiltonian formulation, positive energy theorems, asymptotics, gravitational radiation, singularity theorems, black-holes, cosmology, observational tests. Prerequisite: PHYS 510.

512. QUANTUM THEORY OF SOLIDS I (3) Electrons in periodic potentials; single electron approximations; lattice dynamics; electrical, optical, and magnetic properties of solids; transport theory. Prerequisite: PHYS 412. Concurrent: PHYS 517.

513. QUANTUM THEORY OF SOLIDS II (3) Electron-phonon interaction, BCS theory; Landau Fermi-liquid theory; disorder and localized states; spin-wave theory; many-body theory. Prerequisite: PHYS 512.

514. PHYSICS OF SURFACES, INTERFACES, AND THIN FILMS (3) This course focuses on interfacial and surface phenomena; structural, electronic, vibrational, and thermodynamic properties; physisorption and chemisorption; phase transitions and ultrathin film nucleation; and growth phenomena. Prerequisite: PHYS 412.

517. STATISTICAL MECHANICS (3) Thermodynamics, classical and quantum statistics; Bose and Fermi gases; Boltzmann transport equation; phase transitions, critical phenomena; Ising model. Prerequisites: PHYS 561.

518. CRITICAL PHENOMENA AND FIELD THEORY (3) Critical phenomena using field theoretical and renormalization group techniques; solvable statistical models and conformal field theory; fluctuations and random processes. Prerequisite: PHYS 517, 563.

524. PHYSICS OF SEMICONDUCTORS AND DEVICES (3) Electronic structure, optical and transport properties of crystalline and amorphous semiconductors, quantum wells, superlattices; quantum devices; quantum Hall effect. Prerequisite: PHYS 412.

525. METHODS OF THEORETICAL PHYSICS I (3) Complex variables, Hilbert spaces, linear operators, calculus of variations, Fourier analysis, Green's functions, distributions, differential equations, and special functions.

526. METHODS OF THEORETICAL PHYSICS II (3) Finite and Lie groups, representations and application to condensed matter and particle physics Prerequisite: PHYS 525.

527. COMPUTATIONAL PHYSICS (3) Introduction to and applications of computer simulations and numerical methods to condensed matter, atomic and laser physics, hydrodynamics, nonlinear phenomena, high energy physics and astrophysics.

530. THEORETICAL MECHANICS (3) Newtonian mechanics, noninertial coordinate systems, Lagrangian mechanics, small oscillations, Hamiltonian formulation, canonical transformations, Hamilton-Jacobi theory, dynamical systems. Prerequisite: PHYS 419.

532. THEORETICAL CONTINUUM MECHANICS (3) Wave phenomena, hydrodynamics, heat conduction, elastic continua. Prerequisite: PHYS 530.

533. THEORETICAL ACOUSTICS (3) Wave propagation in complex systems and materials: viscoelastic fluids, superfluids, elastic solids, periodic and random media, nonlinear media.

537. VACUUM PHYSICS (3) An introduction to physical phenomena occurring at low pressures and their applications to the production and measurement of high vacuum.
541. ELEMENTARY PARTICLE PHENOMENOLOGY (3) Baryons and mesons; leptons and quarks; electromagnetic and weak interactions and their unification; quantum chromodynamics; experimental techniques. Prerequisite: PHYS 562.
542. STANDARD MODEL OF ELEMENTARY PARTICLES PHYSICS (3) Weinberg-Salam model of electroweak interactions, spontaneous symmetry breaking, quantum chromodynamics; selected topics from grand unified theories and superstring theory. Prerequisite: PHYS 564.
557. ELECTRODYNAMICS I (3) Electro- and magnetostatics, boundary value problems, Maxwell's equations, field energy-momentum, wave propagation. Prerequisite: PHYS 400.
558. ELECTRODYNAMICS II (3) Wave propagation in media and boundary value problems, radiation theory, scattering theory, special relativity, electrodynamics of relativistic charges. Prerequisite: PHYS 557.
559. GRADUATE LABORATORY (2) Study and applications of techniques and instrumentation used in modern physics laboratories.
561. QUANTUM MECHANICS I (3) Postulates of quantum mechanics, Hilbert space methods, one dimensional potentials, spin systems, Harmonic oscillator, angular momentum, Hydrogen atom. Prerequisite: PHYS 410.
562. QUANTUM MECHANICS II (3) Addition of angular momenta, perturbation theory, variational principle, scattering theory, density matrices, identical particles, interpretations of quantum mechanics, Dirac theory. Prerequisite: PHYS 561.
563. QUANTUM FIELD THEORY I (3) Canonical and functional integral quantization of relativistic and nonrelativistic field theories; Feynman diagrams; spontaneous symmetry breaking; renormalization group. Prerequisite: PHYS 562.
564. QUANTUM FIELD THEORY II (3) Abelian and on-Abelian gauge theories; renormalization group and operator product expansions; BRST quantization; scattering theory, other related topics. Prerequisite: PHYS 563.
565. INTERFACE OF GENERAL RELATIVITY AND QUANTUM PHYSICS (3) Limitations of perturbative methods, conceptual problems; selected topics from black hole thermodynamics, canonical quantum gravity, loop space methods and string-theory. Prerequisites: PHYS 510, 563.
571. ATOMIC, MOLECULAR, AND OPTICAL PHYSICS (3) Atomic and molecular states: mixed perturbations; radiative processes; internal state coherence effects; coherent relaxation, Doppler-free spectroscopies; atom trapping and coding. Prerequisite: PHYS 561.
572. LASER PHYSICS AND QUANTUM ELECTRONICS (3) Theory of lasers; Gaussian optics; nonlinear optics: frequency conversion, nonlinear Raman-type effects, superradiance, photon echoes, phase conjugation; quantum optics. Prerequisite: PHYS 562.
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

PHYSIOLOGY (PHSIO)

DANIEL R. DEEVER, *Chair, In Charge of Program at University Park Campus*
 317 ASI Building
 814-865-3097 or (814) 863-3664
 Fax 814-863-6042

LEONARD S. JEFFERSON, *In Charge of Program at Hershey*
Chair of the Department of Cellular and Molecular Physiology
 Penn State College of Medicine
 Hershey, PA 17033
 (717) 531-8567
 Fax 717-531-7667

Degrees Conferred: Ph.D., M.S.

The Graduate Faculty

David A. Antonetti, Ph.D. (Penn State) *Assistant Professor of Cellular and Molecular Physiology and Ophthalmology*

- Helen A. Baghdoyan, Ph.D. (Connecticut) *Associate Professor of Anesthesia and Pharmacology*
- Kenneth M. Baker, M.D. (Temple) *Professor of Cellular and Molecular Physiology*
- Craig R. Baumrucker, Ph.D. (Purdue) *Professor of Animal Nutrition*
- John L. Beard, Ph.D. (Cornell) *Professor of Nutrition Sciences*
- Sarah K. Bronson, Ph.D. (Washington University) *Assistant Professor of Cellular and Molecular Physiology*
- Joseph G. Cannon, Ph.D. (Michigan) *Professor of Physiology and Kinesiology*
- David J. Carey, Ph.D. (Washington University) *Professor of Cellular and Molecular Physiology*
- Qian Chen, Ph.D. (Tufts) *Assistant Professor of Orthopaedics and Rehabilitation and Cellular and Molecular Physiology*
- Joseph Y. Cheung, M.D. (Duke) *Professor of Medicine and Cellular and Molecular Physiology; Chief, Division of Nephrology*
- Pamela H. Correll, Ph.D. *Assistant Professor of Veterinary Science*
- Elizabeth J. Corwin, Ph.D., CFNP, B.S.N. *Assistant Professor of Nursing*
- Rebecca L. Corwin, Ph.D. (Chicago) *Assistant Professor of Nutrition*
- Ralph J. Damiano, Jr., M.D. (Duke) *Professor of Surgery and Cellular Molecular Physiology, Chief of Division of Cardiothoracic Surgery*
- Zahi Damuni, Ph.D. (U. Dundee) *Associate Professor of Cellular and Molecular Physiology*
- Jonathan R. Day, Ph.D. (Delaware) *Assistant Professor of Biological Sciences*
- Daniel R. Deaver, Ph.D. (West Virginia) *Professor of Reproductive Physiology*
- Jonathan R. Diamond, M.D. (SUNY) *Professor of Medicine and Cellular and Molecular Physiology*
- Henry J. Donahue, Ph.D. (California) *Associate Professor of Orthopaedics and Cellular and Molecular Physiology; Director, Muscular Skeletal Research*
- Terry D. Etherton, Ph.D. (Minnesota) *Professor of Animal Nutrition*
- Peter A. Farrell, Ph.D. (Arizona) *Professor of Physiology*
- Joanna Floros, Ph.D. (Temple) *Professor of Cellular and Molecular Physiology and Pediatrics*
- Roger P. Gaumond, Ph.D. (Washington) *Associate Professor of Bioengineering*
- Thomas W. Gardner, M.D., Ph.D. (Jefferson/Penn State) *Associate Professor of Ophthalmology and Cellular and Molecular Physiology*
- Carol V. Gay, Ph.D. (Penn State) *Professor of Molecular and Cell Biology*
- Michael H. Green, Ph.D. (California, Berkeley) *Professor of Nutrition Science*
- James M. Hammond, M.D. (Washington) *Professor of Medicine and Cellular and Molecular Physiology; Chief, Division of Endocrinology, Diabetes, and Metabolism*
- Wesley C. Hymer, Ph.D. (Wisconsin) *Professor of Biochemistry*
- Leonard S. Jefferson, Jr., Ph.D. (Vanderbilt) *Evan Pugh Professor and Chair, Cellular and Molecular Physiology; Senior Associate Dean for Research and Graduate Studies*
- S. E. Johnson, Ph.D. *Assistant Professor of Poultry Science and Physiology*
- Byron C. Jones, Ph.D. (Arizona) *Associate Professor of Biobehavioral Health*
- Gordon L. Kauffman, M.D. (Michigan) *Professor of Surgery and Cellular and Molecular Physiology*
- W. Larry Kenney, Ph.D. (Penn State) *Professor of Physiology and Kinesiology*
- Ronald S. Kensinger, Ph.D. (Florida) *Associate Professor of Animal Nutrition/Physiology*
- Gary J. Killian, Ph.D. (Penn State) *Professor of Reproductive Physiology*
- Scot R. Kimball, Ph.D. (Vermont) *Associate Professor of Cellular and Molecular Physiology*
- John P. Kirwan, Ph.D. (Ball State) *Assistant Professor of Applied Physiology*
- Charles H. Lang, Ph.D. (Hahnemann) *Professor of Cellular and Molecular Physiology and Surgery*
- Erik Langhoff, M.D., Ph.D. (University of Copenhagen) *Professor of Medicine and Cellular and Molecular Physiology*
- Kathryn F. LaNoue, Ph.D. (Yale) *Professor of Cellular and Molecular Physiology*
- Lars G. Larsson, M.D., Ph.D. *Marie Underhill Noll Professor of Physiology and Clinical Neurophysiology*
- Roland M. Leach, Jr., Ph.D. (Wisconsin) *Professor of Poultry Science*
- Ralph Lydic, Ph.D. (Texas Tech.) *Professor of Anesthesia and Cellular and Molecular Physiology*
- Christopher J. Lynch, Ph.D. (Northeastern) *Associate Professor of Cellular and Molecular Physiology*
- David A. MacLean, Ph.D. (University of Guelph) *Assistant Professor of Medicine and Cellular and Molecular Physiology*
- William A. Maltese, Ph.D. (Syracuse) *Professor of Cellular and Molecular Physiology*
- Magdi M. Mashaly, Ph.D. (Wisconsin) *Associate Professor of Poultry Science*
- Janette M. McAllister, Ph.D. (California, San Diego) *Assistant Professor of Cellular and Molecular Physiology*
- Robert B. Mitchell, Ph.D. (Brown) *Professor of Biology*

- Glenn E. Mortimore, M.D. (Oregon) *Professor Emeritus of Cellular and Molecular Physiology*
 Stephen A. Osmani, Ph.D. (Kings College) *Professor of Cellular and Molecular Physiology*
 James A. Pawelczyk, Ph.D. (North Texas) *Assistant Professor of Physiology and Kinesiology*
 Anthony E. Pegg, Ph.D. (Cambridge) *Evan Pugh Professor of Cellular and Molecular Physiology and Pharmacology; J. Lloyd Huck Professor of Cell and Molecular Biology*
 Patrick G. Quinn, Ph.D. (Michigan) *Associate Professor of Cellular and Molecular Physiology*
 D. Eugene Rannels, Jr., Ph.D. (Penn State) *Distinguished Professor and Vice Chairman of Cellular and Molecular Physiology*
 Stephen R. Rannels, Ph.D. (Penn State) *Associate Professor of Cellular and Molecular Physiology*
 Janet D. Robishaw, Ph.D. (Penn State) *Professor of Cellular and Molecular Physiology*
 Barbara J. Rolls, Ph.D. (Cambridge, England) *Professor and Guthrie Chair in Nutrition*
 Lawrence D. Rothblum, Ph.D. (Hahnemann) *Professor of Cellular and Molecular Physiology*
 Russell C. Scaduto, Jr., Ph.D. (Indiana) *Associate Professor of Cellular and Molecular Physiology*
 Neil A. Sharkey, Ph.D. (California, Davis) *Associate Professor of Kinesiology*
 Jill P. Smith, M.D. (Florida) *Associate Professor of Medicine, Division of Gastroenterology*
 Michael B. Smith, Ph.D. (Arkansas) *Associate Professor of Radiology and Cellular and Molecular Physiology, and Biochemistry and Molecular Biology*
 Lorraine M. Sordillo, Ph.D. (Louisiana) *Associate Professor of Veterinary Science*
 Bruce A. Stanley, Ph.D. (Cornell) *Assistant Professor of Cellular and Molecular Physiology*
 John M. Tarbell, Ph.D. (Delaware) *Professor of Chemical Engineering*
 James Ultman, Ph.D. (Delaware, Newark) *Professor of Chemical Engineering*
 Thomas C. Vary, Ph.D. (Penn State) *Professor of Cellular and Molecular Physiology*
 Regina Vasilatos-Younken, Ph.D. (Penn State) *Associate Professor of Poultry Science*
 Keith Verner, Ph.D. (Cornell) *Associate Professor of Pediatrics and Cellular and Molecular Physiology; Director, Public Science and Health Education Programs*
 Carol F. Whitfield, Ph.D. (George Washington) *Associate Professor of Cellular and Molecular Physiology*
 Nancy I. Williams, Sc.D. (Boston) *Assistant Professor of Kinesiology*
 Robert F. Zelis, M.D. (Chicago) *Professor of Medicine and Cellular and Molecular Physiology; Director, Research in Cardiology*

This is an intercollege program designed to enable students to obtain an integrated series of courses encompassing both the fundamentals of physiology and advanced training in a specialized area. Courses can be taken either at The Milton S. Hershey Medical Center or at University Park campus.

Graduate instruction in physiology is under the direction of a program committee composed of graduate faculty representing several departments or groups actively participating in the physiology program—including the areas of animal science, animal nutrition, biochemistry, bioengineering, biology, microbiology, molecular biology, nutrition, exercise science, poultry science, and veterinary science—as well as the Department of Cellular and Molecular Physiology at the Medical Center. The instructional staff is composed of faculty in those departments offering graduate courses in various areas of specialization in physiology. The master's program, including courses, laboratory experience, and original research, is designed for completion in approximately two years, while the doctoral degree requires approximately four years.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Students with a 3.00 junior/senior average (on a 4.00 scale) and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

Degree Requirements

Deficiencies in chemistry, biological science, mathematics (through a second course in calculus), and physics must be made up early in the student's graduate program. All candidates (master's and doctoral) must complete a general basic laboratory course in physiology (combined cellular, mammalian, and comparative) before choosing an area of specialization. Possible areas of specialization are cardiovascular and respiratory physiology; cellular and subcellular physiology; comparative physiology; environmental physiology; exercise physiology; physiology of nutrition and metabolism; neurophysiology; renal

PHYSIOLOGY

physiology; and reproductive physiology. The graduate committee for majors shall be appropriately represented by members of the physiology program committee and those of the area of specialization who shall have the responsibility and jurisdiction for determining the course program and research acceptable in satisfying degree requirements. The nonthesis option is available for the M.S. degree on a limited basis.

The communication and foreign language requirement for the Ph.D. degree may be satisfied by one of several options including intermediate knowledge of one foreign language.

Other Relevant Information

The following courses, among others, are available for physiology majors, and their descriptions may be found under the offerings of several departments: AGRO 512, 545; AN SC 420, 431, 510, 514, 515; A NTR 401, 501, 503; BIOCH 401, 402, 403, 417, 437, 514, 520, 525; BIOE 402, 501, 502, 503, 504, 505, 506, 507, 552, 553, 570; BIOL 409, 428, 429, 437, 465, 466, 467, 472, 473, 477, 479, 538, 539, 550; CMPSC 403, 412, 413; EDPSY 400, 406, 450, 506, 507; E E 405, 569; FD SC 521; HL ED 511, 513; KINES 455, 456, 457, 480, 484, 530, 565, 567, 577, 580, 582, 584, 586, 587; MICRB 400, 401, 410, 412, M C B 440, 476, 485; NUC E 405, 420; NUTR 452, 457, 458, 459, 552, 557, 558; PHSIO 407 (PTYSC 407), 503, 506, 507; PHYS 400, 402, 420; PTYSC 424, 455; PSY 402, 450, 456, 527; STAT 451, 460, 462, 464, 501, 502, 505; V SC 405, 418, 420, 525, 528, 550.

The following courses are offered at The Milton S. Hershey Medical Center: ANAT 503, 505, 510, 512, 515, 530, 535, 542, 543, 544, 545, 550; BCHEM 502, 503, 505, 513, 523, 528, 551, 553; L A M 501, 503, 507, 510, 515; MICRO 552, 554, 555, 559; NEURO 509, 510, 515, 526, 527, 528, 550; PHARM 502, 505, 511, 515, 520, 540, 550. Descriptions of these courses can be found under the designated program.

Student Aid

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AID section of the *Graduate Bulletin*, the following awards typically have been available to graduate students in this program:

NATIONAL INSTITUTE OF AGING TRAINEESHIPS—Available to doctoral students in selected graduate programs for research training in adult development and aging; stipend varies. Details available from the Gerontology Center, S210 Henderson Building South.

NATIONAL INSTITUTES OF HEALTH—General Medical Sciences: Predoctoral Training Grant. Available to doctoral students interested in multilevel approaches to the study of physiology.

MRS. A. ROBERT NOLL GRADUATE FELLOWSHIP IN APPLIED PHYSIOLOGY—For graduate research in applied physiology, especially in environmental or exercise physiology; stipend variable.

PHYSIOLOGY (PSIO)—Hershey

500. (HMN) **HUMANITIES SCIENTIFIC INTEGRITY** (1) A course on ethical and philosophical problems in the biomedical and behavioral sciences for graduate students and fellows.

501. **SCIENTIFIC ANALYSIS AND PRESENTATION** (1) Journal club format used to develop critical analytical and presentation skills for understanding and clearly presenting current scientific data.

502. **ADVANCED TOPICS IN CELLULAR AND MOLECULAR PHYSIOLOGY** (2) A discussion and literature-based second-year course focused on current topics in cellular and molecular physiology.

511. (NEURO) **NEUROBIOLOGY** (3) Structure and physiology of central and peripheral nervous systems, including specific sense organs.

520. **MEDICAL PHYSIOLOGY** (2) Cellular physiology including membrane permeability, bioelectric potentials, muscular contractions, secretion; metabolic physiology, including control of metabolism by hormones.

521. **MEDICAL PHYSIOLOGY** (4) Organ physiology; examination of respiratory, renal, gastrointestinal, and cardiovascular physiology.

525. **GENERAL PHYSIOLOGY** (2) Cellular processes of accumulation, membrane transport, bioelectric potentials, contraction, and secretion in erythrocytes, nerves, sensory receptors, muscles, glands, excretory organs.

526. (NEURO) **MOLECULAR NEUROSCIENCE** (2) An in-depth discussion of the molecular nature of various components of neurotransmission.

527. (NEURO) **NEUROBIOLOGY OF THE VISUAL SYSTEM** (2) An updated and detailed review of the molecular and cellular mechanism of visual processes.

530. (CMBIO) **METABOLIC AND ENDOCRINE PHYSIOLOGY** (3) Regulation of carbohydrates, fatty acid, and protein metabolism; regulation of hormone secretion; effects of hormones on water and cell metabolism.

534. **HEART AND SKELETAL MUSCLE** (2) Discussion of structure, chemistry, and physiology of heart and skeletal muscle. Prerequisites: PSIO 520, 521.

536. **GASTROINTESTINAL PHYSIOLOGY (2)** Mechanisms of absorption and secretion by stomach, intestine, pancreas, and gallbladder. Neural and hormonal regulation, bioelectric potentials, pathophysiology. Prerequisite: PSIO 521.
538. **PULMONARY PHYSIOLOGY (2)** Discussion of selected topics in pulmonary physiology emphasizing areas of current research in both respiratory and nonrespiratory lung functions. Prerequisites: PSIO 520, 521.
540. **(CMBIO) CELL BIOLOGY (3)** Lectures in cell biology, including membrane, cytoskeleton, and organelle structure and function; cell division, differentiation, adhesion, communication, and movement. Prerequisite: BCHEM 502.
585. **MAGNETIC RESONANCE IMAGING AND SPECTROSCOPY (3)** Applications of magnetic resonance spectroscopy and imaging to biochemistry, physiology, and medicine.
590. **COLLOQUIUM (1–3)**
596. **INDIVIDUAL STUDIES (1–9)**
597. **SPECIAL TOPICS (1–9)**

PHYSIOLOGY (PHSIO)—University Park Campus

509. **(KINES) INFLAMMATORY RESPONSES TO INJURY AND ENVIRONMENTAL STRESS (3)** An examination of mechanisms involved in the inflammatory response and their relationship to general health, injury, and environmental adaptation. Prerequisites: B M B 121, BIOL 472, 473.
510. **PHYSIOLOGICAL ADAPTATIONS TO STRESS (3)** Students will learn how to address problems in physiological adaptations to stress through parallel molecular, cellular, and systemic approaches. Prerequisites: PHSIO 571, 572.
567. **(KINES) ADVANCED EXERCISE PHYSIOLOGY (3)** Physiological changes during exercise, with emphasis on the effects of physical conditioning and training. Prerequisites: BIOL 472, KINES 480.
568. **(KINES) APPLIED SKELETAL MUSCLE PHYSIOLOGY (3)** An in-depth advanced understanding of the structural, morphological, and biochemical functions of muscle and changes with exercise. Prerequisite: BIOL 472, 473, KINES 480.
569. **(KINES) LABORATORY PROCEDURES IN APPLIED PHYSIOLOGY (3)** Laboratory-based study of procedures used to measure physiological and metabolic responses and adaptations to exercise, environmental, and dietary interventions. Prerequisite: BIOL 472.
571. **(BIOL) ANIMAL PHYSIOLOGY (3)** Mammalian cardiovascular, respiratory, renal, and gastrointestinal systems. Prerequisite: BIOL 472, 473.
572. **(BIOL) ANIMAL PHYSIOLOGY (3)** Mammalian nervous, endocrine, metabolic, and reproductive systems. Prerequisite: BIOL 472, 473.
577. **(KINES) CARDIOVASCULAR PHYSIOLOGY (3)** In-depth study of the heart and circulatory system with emphasis on the effects of exercise on cardiovascular function. Prerequisite: KINES 484.
580. **(KINES) ANALYSIS OF BODY COMPOSITION (3)** Study of the methods employed in the analysis of body composition. Prerequisite: BIOL 472 or 3 credits in physiology at the 400 or 500 level.
585. **(KINES) ENVIRONMENTAL PHYSIOLOGY (3)** Human physiological response and adaptation to environmental (heat, cold, altitude) extremes. Prerequisite: 3 credits in physiology at the 400 or 500 level.
586. **(KINES) RESEARCH METHODS IN APPLIED PHYSIOLOGY (3)** Historical and current procedures for evaluation of cardiopulmonary function, metabolism, and thermal balance in humans; lecture, demonstration, and student laboratory. Prerequisite: 3 credits in physiology at the 400 or 500 level.
587. **(KINES) APPLIED PHYSIOLOGY: AMBIENT PRESSURE (3)** Physiological mechanisms activated by exposure to environmental pressure. Prerequisite: KINES 480 or 3 credits in physiology at the 400 or 500 level.
590. **COLLOQUIUM (1–3)**
595. **(EXSCI) INTERNSHIP IN EXERCISE PHYSIOLOGY AND CARDIAC REHABILITATION (1–15)** Clinical and related research aspects of exercise physiology and exercise prescription with respect to cardiac and cardiovascular rehabilitation. Prerequisites: KINES 456, 457, 480, PHSIO 571, 572, 590; completion of one year of graduate work.
596. **INDIVIDUAL STUDIES (1–9)**
597. **SPECIAL TOPICS (1–9)**

PLANT PATHOLOGY (PPATH)

ELWIN L. STEWART, *Head of the Department*
211 Buckhout Laboratory
814-865-7448

Degrees Conferred: Ph.D., M.S., M.Agr.

The Graduate Faculty

John E. Ayers, Ph.D. (Penn State) *Professor of Plant Pathology*
James R. Bloom, Ph.D. (Wisconsin) *Professor Emeritus of Plant Pathology*
John S. Boyle, Ph.D. (Wisconsin) *Professor Emeritus of Plant Pathology*
Barbara J. Christ, Ph.D. (British Columbia) *Associate Professor of Plant Pathology*
Herbert Cole, Jr., Ph.D. (Penn State) *Professor of Plant Pathology*
Donald D. Davis, Ph.D. (Penn State) *Professor of Plant Pathology*
Hector E. Flores, Ph.D. (Yale) *Professor of Plant Pathology and Biotechnology*
David M. Geiser, Ph.D. (Georgia) *Assistant Professor of Plant Pathology*
Frederick E. Gildow, Ph.D. (Cornell) *Associate Professor of Plant Pathology*
Stewart M. Gray, Ph.D. (North Carolina State) *Adjunct Assistant Professor of Plant Pathology*
John M. Halbrendt, Ph.D. (Missouri) *Associate Professor of Plant Pathology*
Kenneth D. Hickey, Ph.D. (Penn State) *Professor of Plant Pathology*
Seogchan Kang, Ph.D. (Wisconsin) *Assistant Professor of Plant Pathology*
Leon R. Kneebone, Ph.D. *Professor Emeritus of Botany and Plant Pathology*
Felix L. Lukezic, Ph.D. (California) *Professor of Plant Pathology*
Alan A. MacNab, Ph.D. (Cornell) *Professor of Plant Pathology*
Walter F. O. Marasas, Ph.D. (Wisconsin) *Adjunct Professor of Plant Pathology and Veterinary Science*
William Merrill, Jr., Ph.D. (Minnesota) *Professor of Plant Pathology*
Wilford R. Mills, Ph.D. *Professor Emeritus of Plant Pathology*
Gary W. Moorman, Ph.D. (North Carolina State) *Professor of Plant Pathology*
Mary E. Palm, Ph.D. (Minnesota) *Adjunct Associate Professor of Plant Pathology*
Eva J. Pell, Ph.D. (Rutgers) *Steimer Professor of Agriculture*
Stanley P. Pennypacker, Ph.D. (Penn State) *Professor of Plant Pathology*
C. Peter Romaine, Ph.D. (Cornell) *Associate Professor of Plant Pathology*
Daniel J. Royse, Ph.D. (Illinois) *Professor of Plant Pathology*
Gary Samuels, Ph.D. (Columbia) *Adjunct Professor of Plant Pathology*
Richard D. Schein, Ph.D. (California) *Professor Emeritus of Plant Pathology*
Lee C. Schisler, Ph.D. (Penn State) *Professor Emeritus of Plant Pathology*
Robert T. Sherwood, Ph.D. (Wisconsin) *Adjunct Professor of Plant Pathology*
John M. Skelly, Ph.D. (Penn State) *Professor of Plant Pathology*
James W. Travis, Ph.D. (North Carolina State) *Professor of Plant Pathology*
Wakar Uddin, Ph.D. (Georgia) *Assistant Professor of Plant Pathology*
Paul J. Wuest, Ph.D. (Penn State) *Professor of Plant Pathology*

Plant pathology is the study of disease in plants and concerns the dynamic interaction between the plant, the causal agent (bacteria, fungi, viruses, nematodes, etc.), and their environments. A student prepares for a professional career in research, teaching, extension, or industry through advanced studies of the principles of plant infection, the physiology of disease in plants, the ecology of root diseases, the nature and inheritance of disease resistance in plants, epidemiology, ecology and physiology of air pollution injury to plants, or plant disease control by biological or chemical means. A student also may specialize in the nature and control of the diseases of forest trees, agronomic or horticultural crops, and commercial mushrooms. Advanced studies in applied mycology, related to the production of the commercial mushroom, also may be taken. Modern, well-equipped laboratories, controlled environment facilities and greenhouses, and well-developed field research areas are available for graduate study.

Admission Requirements

Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate

study in a program without these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Students scoring in the fiftieth percentile or above on each section of the GRE will be given preference. The best-qualified applicants will be accepted up to the number of spaces and advisers that are available for new students. Students with a 2.80 junior/senior average (on a 4.00 scale) and with appropriate course backgrounds will be considered for admission. Exceptions to the minimum 2.80 grade-point average may be made for students with special backgrounds, abilities, and interests.

For admission a student must present 42 credits in the sciences, including a minimum of 15 credits in mathematics, chemistry, or physics and a minimum of 15 credits, including a basic botany course in the plant sciences. Students with a strong background in agronomy, biochemistry, biophysics, botany, forestry, genetics, horticulture, or microbiology are usually well prepared for advanced study in plant pathology.

Degree Requirements

Specific requirements for the M.S. and Ph.D. programs are available on request.

The Master of Agriculture degree is offered to provide professional training in plant pathology with more of a crop orientation than is available under the M.S. program. In addition to the courses required for an M.S. degree, the M.Agr. degree requires further study in the areas of entomology and crop sciences. A thesis substitute, such as an internship report, or an adaptive or demonstrative activity whereby known technology or procedures are applied, is acceptable.

Competency in a foreign language is not required for the Ph.D. degree. However, depending upon the nature of the thesis research and with the advice and consent of the doctoral advisory committee, competency in a foreign language may be judged to be an essential part of the doctoral studies of certain students.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

PLANT PATHOLOGY (PPATH)

416. MYCOLOGY AND PLANT VIROLOGY: MOLECULES TO POPULATIONS (4)

417. BACTERIA AND ABIOTIC STRESS-CAUSING PLANT DISEASES (4)

419. BACTERIA AND NEMATODES CAUSING PLANT DISEASES (4)

426. PLANT PATHOGENIC FUNGI (3)

496. INDEPENDENT STUDIES (1-18)

497. SPECIAL TOPICS (1-9)

502. PLANT DISEASE DIAGNOSIS (3) Field and laboratory techniques used in diagnosing plant diseases caused by various types of pathogens with emphasis on fungi. Prerequisites: PPATH 426.

505. FUNDAMENTALS OF PHYTOPATHOLOGY (2) An in-depth tutorial of the fundamental theories and concepts of plant pathology. Prerequisite: PPATH 405.

535. PRINCIPLES OF PLANT EPIDEMIOLOGY (3) Analytical methodology useful in describing pest epidemics on crop populations and the application of this information for pest control. Prerequisites: AGRO 512.

540. PLANT DISEASE CONTROL (3) Principles of plant disease control, including theoretical considerations involved in control by chemical and nonchemical means.

542. EPIDEMIOLOGY OF PLANT DISEASE (3) Disease development in populations of plants, with emphasis on the impact of environment and control practices on rate of development. Prerequisites: MATH 111 or 141, or 3 credits in statistics.

543. PATHOGEN VARIATION AND HOST RESISTANCE (3) Mechanisms and implications of genetic variation in plant pathogens related or breeding for disease resistance in plants by genetic means. Prerequisite: AGRO 411 or HORT 407.

545. (PLPHY) PLANT BIOTECHNOLOGY (3) Overview of classic and recent developments in plant cell culture technology, plant cell engineering, and plant genetic engineering. Prerequisite: BIOL 441.

560. PRINCIPLES OF PLANT PATHOLOGY (3) Open-ended discussions of concepts of plant pathology, with emphasis on their interrelationships and their significance to the science.

590. COLLOQUIUM (1-3)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

PLANT PHYSIOLOGY (PLPHY)

EVA J. PELL, *Head of the Graduate Program in Plant Physiology*
211 Buckhout Laboratory
(814) 865-0323

Degrees Conferred: Ph.D., M.S.

The Graduate Faculty

Marc D. Abrams, Ph.D. (Michigan State) *Associate Professor of Forest Ecology/Physiology*
Richard N. Artica, Ph.D. (Washington State) *Professor of Horticultural Physiology*
Sarah Assmann, Ph.D. (Stanford) *Associate Professor of Biology*
Robert D. Berghage, Ph.D. (Michigan State) *Assistant Professor of Horticulture*
Kathleen B. Brown, Ph.D. (Florida) *Associate Professor of Postharvest Physiology*
Donald A. Bryant, Ph.D. (California) *Ernest C. Pollard Professor of Biotechnology and Professor of Biochemistry and Molecular Biology*
John Carlson, Ph.D. (University of Illinois) *Associate Professor of School of Forestry Resources*
Daniel Cosgrove, Ph.D. (Stanford) *Professor of Biology*
Wayne R. Curtis, Ph.D. (Purdue) *Associate Professor of Chemical Engineering and Biotechnology*
Richard J. Cyr, Ph.D. (California, Irvine) *Associate Professor of Biology*
David M. Eissenstat, Ph.D. (Utah State) *Associate Professor of Woody Plant Physiology*
Nina V. Fedoroff, Ph.D. (Rockefeller U) *Willaman Professor of Life Sciences*
Hector E. Flores, Ph.D. (Yale) *Associate Professor of Plant Pathology and Biotechnology*
Majid Foolad, Ph.D. (California, Davis) *Assistant Professor of Plant Genetics*
Simon Gilroy, Ph.D. (Edinburgh) *Assistant Professor of Biology*
Mark J. Guiltinan, Ph.D. (California, Irvine) *Assistant Professor of Plant Molecular Biology*
David L. Gustine, Ph.D. (Michigan State) *Adjunct Associate Professor of Crop Physiology*
Charles W. Heuser, Ph.D. (Rutgers) *Associate Professor of Horticultural Physiology*
David Huff, Ph.D. (University of California-Davis) *Assistant Professor of Agronomy*
Seogchan Kang, Ph.D. (Wisconsin) *Assistant Professor of Plant Pathology*
Teh-Hui Kao, Ph.D. (Yale) *Associate Professor of Biochemistry and Molecular Biology*
Daniel P. Kniesel, Ph.D. (Wisconsin) *Associate Professor of Crop Physiology*
Roger Koide, Ph.D. (California) *Associate Professor of Horticultural Ecology*
Jonathan P. Lynch, Ph.D. (California, Davis) *Assistant Professor of Plant Nutrition*
Karen J. Miller, Ph.D. (Massachusetts) *Associate Professor of Food Science*
Christopher A. Mullin, Ph.D. (Cornell) *Associate Professor of Entomology*
B. Tracy Nixon, Ph.D. (MIT) *Associate Professor of Biochemistry and Molecular Biology*
Eva J. Pell, Ph.D. (Rutgers) *Steimer Professor of Agriculture*
Ramesh Raina, Ph.D. (Jawahar Lal Nehru U) *Assistant Professor of Biology*
John C. Schultz, Ph.D. (Washington) *Professor of Entomology*
Jack C. Shannon, Ph.D. (Illinois) *Professor of Plant Physiology*
Andrew G. Stephenson, Ph.D. (Michigan) *Professor of Biology*

The intercollege program in Plant Physiology includes faculty from eight departments in the Colleges of Agricultural Sciences, Engineering, Forestry and Science. Each student becomes associated with the adviser's department which may provide financial support, research facilities, and office space. Applicants are encouraged to explore opportunities by contacting faculty who may be prospective advisers.

The objective of this program is to educate and train plant physiologists for positions in industry, government, research institutes, and colleges and universities. Faculty in this program are competent to prepare candidates in almost all subfields of plant physiology including photosynthesis; photophysiology; translocation and assimilate partitioning; respiration; short distance solute transport and membrane physiology; organelle isolation and characterization; enzymology; synthesis and metabolism of carbohydrates, proteins, glycoproteins, and nucleic acids; phytohormone synthesis, breakdown, and action; mineral nutrition; nitrogen fixation; inorganic and organic nitrogen metabolism; plant molecular biology; plant tissue culture; postharvest physiology; fruit and seed development, dormancy, and germination; stress and environmental physiology; host-pathogen relationships and others.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are required for admission. At the discretion of the graduate program officers, a student may be admitted provisionally for graduate study in a program without

these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Students with a 3.00 junior/senior grade-point average (on a 4.00 scale) and with appropriate course background will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces available for new students. Students entering this program should have had a strong foundation in the biological sciences, including biochemistry, general physics, and college mathematics through calculus. Students with limited deficiencies may be admitted but must make up their deficiencies concurrently with their graduate studies. B.S.-level applicants with good academic records who have had strong training in plant physiology and related courses, including research experience, may be admitted directly into the Ph.D. program and bypass the M.S. degree.

Master's Degree Requirements

Candidates for the M.S. must take a written diagnostic examination during the first academic year in the program. The functions of this test are to (1) determine the areas of expertise and deficiency in the student's academic preparation and (2) serve as an early screening system to eliminate students with too great an academic deficiency to continue in the program.

All M.S. degree candidates will be required to complete two biochemistry courses two four credit courses introducing Advanced Topics in Plant Physiology; (PLPHY 512 and 513) and 2 credits of colloquium (PLPHY 590). Upon recommendation of the advisory committee, equivalent courses taken at another university may be substituted for the above requirements. All M.S. candidates must complete a thesis, and at least 6 credits of thesis research (PLPHY 600 or 610) must be included in the program.

Doctoral Degree Requirements

Students in the Ph.D. program must successfully pass a written candidacy examination in addition to the oral candidacy, comprehensive, and final examinations required by the Graduate School. The functions of the written candidacy are the same as those of the diagnostic examination given the M.S. degree candidates. The written candidacy will be administered in the first year of a student's program.

Ph.D. candidates must complete the courses required for the M.S. plus a three 2 credit courses dealing with theory and techniques of Plant Ecophysiology, Plant Cell Biology, and Plant Molecular Biology (PLPHY 514, 515, 516) and 3 credits of colloquium (PLPHY 590). Upon recommendation of the candidacy committee, equivalent courses taken at another university may be substituted for some of the above requirements. Other course requirements will be determined by the major professor and the student's advisory committee based on the results of the candidacy examinations.

Other Relevant Information

The following courses, in addition to the required courses, are some of the courses available for plant physiology majors, and their descriptions may be found under the offerings of several departments: AGRO 517, 518; BIOL 407, 431, 441, 448, 510, 513; BMBB 514, 520, 525; HORT 402, 412W, 420, 440W, 444, 445, 507, 520; PPATH 541, 545, 597; any course offered by the Plant Physiology program.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*. In most participating departments, Plant Physiology applicants are eligible for departmental teaching or research assistantships, and other assistantships supported by grant funds of individual faculty who make these award decisions.

PLANT PHYSIOLOGY (PLPHY)

512. PLANT RESOURCE ACQUISITION AND UTILIZATION (4) Advanced study of plant resource acquisition and utilization considering molecular, physiological, and whole plant perspectives through lectures and problem solving. Prerequisite: BIOL 441.

513. INTEGRATIVE PLANT COMMUNICATION AND GROWTH (4) Advanced study of plant communication, growth, and development considering molecular, physiological, and whole plant perspectives through lectures and problem solving. Prerequisite: BIOL 441.

514. (HORT) MODERN TECHNIQUES AND CONCEPTS IN PLANT ECOPHYSIOLOGY (2) An intensive introduction to concepts of plant ecophysiology and modern techniques used in this field. Prerequisite: BIOL 220W.

515. (BIOL) MODERN TECHNIQUES AND CONCEPTS IN PLANT CELL BIOLOGY (2) An intensive introduction to concepts of plant cell biology and modern techniques used in this field. Prerequisite: introductory course in plant physiology.

POLITICAL SCIENCE

516. (BIOL) MODERN TECHNIQUES AND CONCEPTS IN PLANT MOLECULAR BIOLOGY (2)
An intensive introduction to contemporary molecular biology methods as applied to the study of plants.
Prerequisite: general biology and plant physiology at the undergraduate level.
545. (PPATH) PLANT BIOTECHNOLOGY (3) Overview of classic and recent developments in plant cell culture technology, plant cell engineering, and plant genetic engineering. Prerequisite: BIOL 441.
590. COLLOQUIUM (1-4)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

POLITICAL SCIENCE (PL SC)

LAWRENCE A. SCAFF, *Head of the Department*
107 Burrowes Building
814-865-7515; Graduate Program—814-863-1595

Degrees Conferred: Ph.D., M.A

The Graduate Faculty

Henry S. Albinski, Ph.D. (Minnesota) *Professor Emeritus of Political Science and Australian and New Zealand Studies*

Vernon V. Asaturian, Ph.D. (California, Los Angeles) *Evan Pugh Professor Emeritus of Political Science*

Lee Ann Banaszak, Ph.D. (Washington U) *Associate Professor of Political Science*

Frank R. Baumgartner, Ph.D. (Michigan) *Professor of Political Science*

D. Scott Bennett, Ph.D. (Michigan) *Assistant Professor of Political Science*

Michael E. Berkman, Ph.D. (Indiana) *Associate Professor of Political Science*

Michael H. Bernhard, Ph.D. (Columbia) *Associate Professor of Political Science*

William T. Bianco, Ph.D. (Rochester) *Associate Professor of Political Science*

Stuart A. Bremer, Ph.D. (Michigan State) *Professor of Political Science*

Gretchen G. Casper, Ph.D. (Michigan) *Associate Professor of Political Science*

Parris H. Chang, Ph.D. (Columbia) *Professor Emeritus of Political Science*

Stephen J. Cimbala, Ph.D. (Wisconsin) *Professor of Political Science*

C. Michael Comiskey, Ph.D. (Princeton) *Associate Professor of Political Science*

Suzanna L. DeBoef, Ph.D. (Iowa) *Assistant Professor of Political Science*

James Eisenstein, Ph.D. (Yale) *Professor of Political Science*

Robert S. Friedman, Ph.D. (Illinois) *Professor Emeritus of Political Science*

Erik A. Gartzke, Ph.D. (Iowa) *Assistant Professor of Political Science*

Robert E. Harkavy, Ph.D. (Yale) *Professor of Political Science*

Marie E. Hojnacki, Ph.D. (Ohio State) *Assistant Professor of Political Science*

Edward Keynes, Ph.D. (Wisconsin) *Professor Political Science*

Stanley A. Kochanek, Ph.D. (Pennsylvania) *Professor of Political Science*

Robert LaPorte, Jr., Ph.D. (Syracuse) *Professor of Public Administration and Political Science*

Quan Li, Ph.D. (Florida State) *Assistant Professor of Political Science*

Nancy S. Love, Ph.D. (Cornell) *Associate Professor of Political Science*

David J. Myers, Ph.D. (California, Los Angeles) *Associate Professor of Political Science*

Robert E. O'Connor, Ph.D. (North Carolina) *Associate Professor of Political Science*

Eric Plutzer, Ph.D. (Washington U) *Associate Professor of Political Science*

Regina A. Smyth, Ph.D. (Duke) *Assistant Professor of Political Science*

Larry D. Spence, Ph.D. (California, Berkeley) *Associate Professor of Political Science*

Susan Welch, Ph.D. (Illinois, Urbana-Champaign) *Professor of Political Science*

The purpose of the graduate program in Political Science is to train professional political scientists who intend to pursue careers in research, teaching, and public service. The department offers programs leading to the M.A. and Ph.D. degrees. The programs are designed to enable students to acquire both methodological sophistication and substantive knowledge in a variety of fields.

The graduate program in Political Science encourages the study of a variety of substantive concerns, methodological approaches, and research skills. Among the department's special areas of strength are United States politics and political behavior (legislative politics, public opinion and voting, parties and

interest groups, and judicial process); political and social theory; international relations and security studies; and the politics and foreign policies of western and eastern Europe, Latin America, South Asia, and the Pacific rim; international relations, law, and organizations; and a number of public policy areas. The department has a faculty of twenty-four full-time members.

Admission Requirements

Entrance to the Political Science graduate program occurs in the fall semester. Applications must be received by the department not later than January 26 for fall admission. However, the department will begin accepting applications as of September 1.

The Department of Political Science requires M.A. and Ph.D. program applicants to submit transcripts, Graduate Record Examination (GRE) scores (verbal, quantitative, and analytical), a statement of career plans and proposed emphasis in political science, and at least three letters of recommendation from persons familiar with the applicant's academic performance. Students whose native language is not English must also submit the results of the Test of English as a Foreign Language (TOEFL). Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Students can be admitted to the master's program or, after passing a Ph.D. candidacy exam, can be admitted to the Ph.D. program with a master's degree.

Master's Degree Requirements

Depending on the student's previous methodological training, 30 credits of course work, including an essay, are required for a master's degree. The course work includes a methodological core of 6 credits (PL SC 501 and 502); 12 credits in a primary field (including the survey seminar in the field); 6 credits in a secondary field; 3 credits for the M.A. essay; and an additional 3 credits in an elective. There are no language requirements for the degree. Every master's candidate is required to pass a comprehensive examination.

Doctoral Degree Requirements

The Department of Political Science requires a minimum total of 60 postbaccalaureate credits for the Ph.D. Course work accepted for the M.A. in Political Science at Penn State will count toward the 60-credit requirement. At least 45 credits, exclusive of the dissertation, must be in political science.

In the case of transfer students, credits earned in an advanced degree program at another university or in another department at Penn State will count toward the 60-credit requirement.

The department requires that a student complete the designated "core" courses in methodology (PL SC 501, 502, and 503). Ph.D. students are also required to take three of the four subfield survey seminars offered in the department: (1) United States government and politics; (2) comparative politics; (3) international relations; and (4) political theory.

The communication and foreign language requirement for the Ph.D. may be satisfied by competence in approved skills selected from foreign languages, statistics, or mathematics and computer science.

Ph.D. degree candidates must present three fields for the purposes of comprehensive examinations. The major and one of the minor fields must be selected from the department's recognized fields, and one of the minor fields may be outside political science.

Other Relevant Information

Penn State is a member of the Committee on Institutional Cooperation (CIC), an association of the Big Ten universities and the University of Chicago. The CIC sponsors the Traveling Scholars program, which provides doctoral-level students with an opportunity to study at another CIC university. In addition to participating in CIC programs, the department sponsors attendance at the ICPSR Summer program at the University of Michigan.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

POLITICAL SCIENCE (PL SC)

- 403. THE LEGISLATIVE PROCESS (3)
- 405. THE AMERICAN PRESIDENCY (3)
- 408. INTRODUCTION TO POLITICAL RESEARCH (3)
- 409. QUANTITATIVE POLITICAL ANALYSIS (3)

412. INTERNATIONAL POLITICAL ECONOMY (3)
413. THE RISE AND FALL OF THE SOVIET UNION (3)
414. FOREIGN POLICY OF THE SOVIET UNION (3)
415. INTERNATIONAL ORGANIZATION: POLITICAL AND SECURITY FUNCTIONS (3-6)
416. INTERNATIONAL LAW (3)
417. AMERICAN LOCAL GOVERNMENT AND ADMINISTRATION (3)
418. INTERNATIONAL RELATIONS THEORY (3)
419. BUREAUCRACY AND PUBLIC POLICY (3)
420. POLICY MAKING AND EVALUATION (3)
422. COMPARATIVE URBAN POLITICS (3)
425. GOVERNMENT AND POLITICS OF THE AMERICAN STATES (3)
426. POLITICAL PARTIES AND INTEREST GROUPS (3)
427. POLITICAL OPINION (3)
428. (WMNST) GENDER AND POLITICS (3)
430. SELECTED WORKS IN THE HISTORY OF POLITICAL THEORY (3)
431. ANCIENT, MEDIEVAL, AND RENAISSANCE POLITICAL THEORIES (4)
432. MODERN AND CONTEMPORARY POLITICAL THEORIES (4)
435. FOUNDATIONS OF AMERICAN POLITICAL THEORY (3)
- 435W. FOUNDATIONS OF AMERICAN POLITICAL THEORY (3)
437. WAR IN WORLD POLITICS (3)
438. NATIONAL SECURITY POLICIES (3)
- 439.(ADM J) THE POLITICS OF TERRORISM (3)
442. AMERICAN FOREIGN POLICY (3)
443. AMERICAN SECURITY PROBLEMS (3)
444. GOVERNMENT AND THE ECONOMY (3)
450. CANADIAN AND AUSTRALIAN POLITICS AND FOREIGN POLICIES (3)
451. COMPARATIVE POLITICAL ANALYSIS (3)
452. GOVERNMENTS AND POLITICS OF EASTERN EUROPE (3)
453. POLITICAL PROCESSES IN UNDERDEVELOPED SYSTEMS (3-6)
454. GOVERNMENT AND POLITICS OF AFRICA (3)
455. GOVERNMENTS AND POLITICS OF WESTERN EUROPE (3)
456. POLITICS AND INSTITUTIONS OF LATIN AMERICAN NATIONS (3)
457. INTERNATIONAL POLITICS OF LATIN AMERICA (3-6)
458. GOVERNMENT AND POLITICS OF EAST ASIA (3-6)
460. (S T S) SCIENCE, TECHNOLOGY, AND PUBLIC POLICY (3)
462. MARXIST AND SOCIALIST POLITICAL THEORY (3)
466. COMPARATIVE FOREIGN POLICIES OF WESTERN EUROPE (3)
467. INTERNATIONAL RELATIONS OF THE MIDDLE EAST (3)
468. INTERNATIONAL RELATIONS OF EAST ASIA (3)
- 470W. LEGAL BRIEF WRITING (3)
471. ADMINISTRATIVE LAW (3)
472. THE AMERICAN LEGAL PROCESS (3)
473. CONSTITUTIONAL LAW: THE FEDERAL SYSTEM (3)
474. CONSTITUTIONAL LAW: EQUAL PROTECTION (3)
475. CONSTITUTIONAL LAW: SUBSTANTIVE DUE PROCESS RIGHTS (3)
494. RESEARCH PROJECT (1-12)
495. POLITICAL SCIENCE INTERNSHIP (1-9)
496. INDEPENDENT STUDIES (1-18)
497. SPECIAL TOPICS (1-9)
499. FOREIGN STUDY—GOVERNMENT (2-6)
501. METHODS OF POLITICAL ANALYSIS (3) Survey of important methods and approaches to the study of politics; introduction to research design.
502. STATISTICAL METHODS FOR POLITICAL RESEARCH (3) Basic concepts of statistics and their use in political research; data analysis, casual inference, regression analysis, computer applications.
503. MULTIVARIATE ANALYSIS FOR POLITICAL RESEARCH (3-6) Analysis of selected issues in quantitative political analysis; introduction to advanced multivariate analysis techniques. Prerequisite: PL SC 501, 502.
540. AMERICAN GOVERNMENT AND POLITICS (3) Survey of basic literature in major fields of U.S. government: public opinion, parties, voting, interest groups, presidency, congress, judiciary.

541. AMERICAN POLITICAL INSTITUTIONS (3 per semester, maximum of 9) Research on a selected topic in the United States political institutions such as the presidency, the courts, congress, bureaucracy, state governments.
542. AMERICAN POLITICAL BEHAVIOR (3 per semester, maximum of 9) Research on a selected topic in the United States political behavior such as public opinion, voting, parties, socialization, judicial behavior.
543. AMERICAN PUBLIC POLICY (3 per semester, maximum of 9) Research on topics in United States public policy and public law, such as environmental policy, development policy, individual and minority rights.
550. COMPARATIVE POLITICS: THEORY AND METHODOLOGY (3) Survey of basic literature and major research efforts in comparative political analysis.
551. COMPARATIVE POLITICAL INSTITUTIONS (3 per semester, maximum of 9) Comparative study of the institutional structures of different political systems: the state, party systems, administrative structures.
552. COMPARATIVE POLITICAL BEHAVIOR (3–9) Research on aspects of comparative political behavior, such as political culture, political change and development, interest groups, public opinion.
553. STUDIES IN REGIONAL POLITICS (3 per semester, maximum of 9) Research on political systems in selected regions of the world, such as Europe, Latin America, East and South Asia.
560. INTERNATIONAL RELATIONS: THEORY AND METHODOLOGY (3) Survey of major traditional and contemporary theory-building efforts and contemporary research techniques and orientations in international relations.
561. AMERICAN FOREIGN POLICY (3 per semester, maximum of 6) Research on the institutions, dynamics, and major themes of United States foreign policy.
562. NATIONAL SECURITY STUDIES (3 per semester, maximum of 6) Research on classical and modern conventional strategy, nuclear strategy, arms control, conflict management, and nontraditional security problems.
563. INTERNATIONAL POLITICAL ECONOMY (3) Research on international political economy with a focus on theory building; analysis of political causes and consequences of economic behavior.
564. INTERNATIONAL ORGANIZATION (3 per semester, maximum of 6) Research on international governmental and nongovernmental organizations in the international system, emphasizing the United Nations and collective security. Prerequisite: PL SC 415.
580. MODERN DEMOCRATIC POLITICAL THOUGHT (3) Survey of major themes and problems in modern theories of democratic politics. Prerequisite: PL SC 431 or 432.
581. HISTORY OF POLITICAL THEORY (3 per semester, maximum of 6) Research on selected political theorists or historical traditions of political thought. Prerequisite: PL SC 431 or 432.
582. ANALYTIC POLITICAL THEORY (3 per semester, maximum of 6) Research on problems in contemporary theory construction. Prerequisite: PL SC 431 or 432.
583. MODERN POLITICAL AND SOCIAL THEORY (3 per semester, maximum of 6) Research on major developments and issues in modern political and social theory, such as critical theory, modernism, and postmodernism.
586. THEORY OF BUREAUCRATIC AND ADMINISTRATIVE POLITICS (3 per semester, maximum of 6) The role of the executive in government and politics; theories of administrative organization, organization behavior, and decision-making processes.
594. RESEARCH IN POLITICAL SCIENCE (1–6) Supervised student activities on research projects identified on an individual or small group basis.
595. INTERNSHIP IN POLITICAL SCIENCE (1–9) Supervised off-campus, nongroup instruction, including field experiences, practicums, or internships. Written and oral critique of activity required. Prerequisites: Prior consent of supervisor, adviser, or department head; applicable departmental internship requirements such as satisfactory completion of required upper-level courses appropriate for the internship program selected.
596. INDIVIDUAL STUDIES (1–9)
- 597, 598. SPECIAL TOPICS (1–9)
599. FOREIGN STUDIES (1–12 per semester, maximum of 24)

PSYCHOLOGY (PSY)

KEITH A. CRNIC, *Head of the Department*
 417B Moore Building
 814-865-9515

Degrees Conferred: Ph.D., M.S.

The Graduate Faculty

- William R. Balch, Ph.D. (Minnesota) *Associate Professor of Psychology*
 Karen L. Bierman, Ph.D. (Denver) *Professor of Psychology*
 Thomas D. Borkovec, Ph.D. (Illinois) *Distinguished Professor of Psychology*
 K. Robert Bridges, Ph.D. (Pittsburgh) *Assistant Professor of Psychology*
 Frederick M. Brown, Ph.D. (Virginia) *Associate Professor of Psychology*
 Richard A. Carlson, Ph.D. (Illinois) *Associate Professor of Psychology*
 Louis G. Castonguay, Ph.D. (SUNY, Stony Brook) *Assistant Professor of Psychology*
 Mari L. Clements, Ph.D. (Denver) *Assistant Professor of Psychology*
 Pamela M. Cole, Ph.D. (Penn State) *Professor of Psychology*
 Peter B. Crabb, Ph.D. (Temple) *Associate Professor of Psychology*
 Keith A. Crnic, Ph.D. (Washington) *Professor of Psychology*
 David V. Day, Ph.D. (Akron) *Associate Professor of Psychology*
 Francis J. DiVesta, Ph.D. (Cornell) *Professor Emeritus of Education and Psychology*
 Juris G. Draguns, Ph.D. (Maryland) *Professor Emeritus of Psychology*
 Ruben Echemendia, Ph.D. (Bowling Green) *Clinical Associate Professor of Psychology*
 Michael Eltz, Ph.D. (Denver) *Clinical Assistant Professor of Psychology*
 James L. Farr, Ph.D. (Maryland) *Professor of Psychology*
 Mary Gergen, Ph.D. (Temple) *Professor of Psychology*
 Rick O. Gilmore, Ph.D. (Carnegie Mellon) *Assistant Professor of Psychology*
 Monica E. Gregory, Ph.D. (Oklahoma) *Associate Professor of Psychology*
 George M. Guthrie, Ph.D. (Minnesota) *Professor Emeritus of Psychology*
 Lance W. Hahn, Ph.D. (Texas) *Assistant Professor of Psychology*
 Gordon G. Nagayama Hall, Ph.D. (Fuller Theological Seminary) *Professor of Psychology*
 Helen Hendy, Ph.D. (California) *Assistant Professor of Psychology*
 Janis E. Jacobs, Ph.D. (Michigan) *Associate Professor of Human Development and Family Studies and Psychology*
 Rick R. Jacobs, Ph.D. (California) *Professor of Psychology*
 John A. Johnson, Ph.D. (Johns Hopkins) *Professor of Psychology*
 Deborah A. Kelemen, Ph.D. (Arizona) *Assistant Professor of Psychology*
 Judith F. Kroll, Ph.D. (Brandeis) *Professor of Psychology*
 Frank J. Landy, Ph.D. (Bowling Green) *Professor Emeritus of Psychology*
 Herschel W. Leibowitz, Ph.D. (Columbia) *Evan Pugh Professor Emeritus of Psychology*
 Lynn S. Liben, Ph.D. (Michigan) *Professor of Psychology*
 Richard M. Lundy, Ph.D. (Ohio State) *Professor Emeritus of Psychology*
 Kelly L. Madole, Ph.D. (Texas) *Assistant Professor of Psychology*
 Melvin M. Mark, Ph.D. (Northwestern) *Professor of Psychology*
 James E. Martin, Ph.D. (Illinois) *Associate Professor of Psychology*
 John E. Mathieu, Ph.D. (Old Dominion) *Professor of Psychology*
 Gerald E. McClearn, Ph.D. (Wisconsin) *Evan Pugh Professor of Health and Human Development and Psychology*
 Larry K. Michelson, Ph.D. (Nova) *Professor of Psychology*
 Susan Mohammed, Ph.D. (Ohio) *Assistant Professor of Psychology*
 Cathleen M. Moore, Ph.D. (California) *Assistant Professor of Psychology*
 J. Toby Mordkoff, Ph.D. (Johns Hopkins) *Assistant Professor of Psychology*
 Keith E. Nelson, Ph.D. (Yale) *Professor of Psychology*
 Michelle G. Newman, Ph.D. (SUNY, Stony Brook) *Assistant Professor of Psychology*
 Merrill E. Noble, Ph.D. (Ohio State) *Professor Emeritus of Psychology*
 David S. Palermo, Ph.D. (Iowa) *Professor Emeritus of Psychology*
 Jeffrey G. Parker, Ph.D. (Illinois) *Assistant Professor of Psychology*
 Aaron L. Pincus, Ph.D. (British Columbia) *Associate Professor of Psychology*
 Elizabeth C. Pinel (Texas) *Assistant Professor of Psychology*
 Karen Sue Quigley, Ph.D. (Ohio State) *Assistant Professor of Psychology*
 Richard J. Ravizza, Ph.D. (Vanderbilt) *Associate Professor of Psychology*
 William J. Ray, Ph.D. (Vanderbilt) *Professor of Psychology*
 J. Gowen Roper, Ph.D. (Adelphi) *Clinical Assistant Professor of Psychology*
 David A. Rosenbaum, Ph.D. (Stanford) *Professor of Psychology*
 K. Warner Schaie, Ph.D. (Washington) *Evan Pugh Professor of Human Development and Psychology*

Lael J. Schooler, Ph.D. (Carnegie Mellon) *Assistant Professor of Women's Studies and Psychology*
 Stephanie A. Shields, Ph.D. (Penn State) *Professor of Women's Studies and Psychology*
 Margaret L. Signorella, Ph.D. (Penn State) *Professor of Psychology*
 C. J. R. Simons, Ph.D. (West Virginia) *Associate Professor of Psychology*
 Robert M. Stern, Ph.D. (Indiana) *Distinguished Professor of Psychology*
 Valerie N. Stratton, Ph.D. (Penn State) *Associate Professor of Psychology*
 Janet Swim, Ph.D. (Minnesota) *Professor of Psychology*
 Hoben Thomas, Ph.D. (Claremont) *Professor of Psychology*
 Tiffany Townsend, Ph.D. (George Washington) *Assistant Professor of Psychology*

The graduate Psychology program is characterized by highly individualized study leading to the Ph.D. degree. Emphasis is placed on research, teaching, and professional career development. Each student is associated with one of the six program areas offered in the department: *Clinical* (including *Child Clinical*); *Cognitive*; *Developmental*; *Psychobiology*; *Industrial/Organizational*; and *Social*. An individual's particular pattern of interests dictates in part the course of study followed. Within all areas, research is an integral part of study; usually, the research is empirical in focus, but it may be applied or basic, depending on the problem of interest.

The department has laboratories, computer facilities, darkroom, and shop, and students have access to the large resources of the University, which include an excellent computation facility and large open-stack library. Opportunities for practicum experience are available; e.g., clinical students find practica in local mental health centers, while industrial students find placement in appropriate business or industrial settings.

Admission Requirements

Scores from the Graduate Record Examination (GRE) verbal and quantitative portions are required; scores from the Miller Analogies Test (MAT) are optional. All applicants who were psychology majors as undergraduates should provide scores from the advanced psychology (subject) GRE test. Applicants with superior undergraduate (particularly junior and senior years) or graduate grade-point averages will be considered for admission. Although a major in psychology is not required, applicants should have a broad undergraduate background that includes 12 credits in psychology. Undergraduate study in psychology should include a course in statistics and a psychological methodology course. Requirements listed above are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Master's Degree Requirements

The psychology department does not have a graduate program designed for students seeking only the master's degree. A master's thesis, or the department's equivalent (an acceptable published journal article), is required for advancement to candidacy for the Ph.D. degree in Psychology. Usually, but not always, the master's thesis centers on an empirical research topic. The typical thesis involves a literature review, data collection, analysis, and discussion. A master's degree is not awarded unless a thesis is submitted to the Graduate School.

Doctoral Degree Requirements

All students in their first year of residency must satisfactorily complete the department's English proficiency test.

Students must complete (within their first 60 graduate credits for students without previous graduate credit) 6 departmentally approved graduate credits in statistics with a grade of B or better. Additionally, students must complete, for graduate credit, departmentally approved courses in each of the following four areas: biological, cognitive, social and industrial, and individual differences psychology. Only a grade of B or better in each course satisfies the requirement, which must be completed prior to the time the doctoral comprehensive examination is taken. Students must complete 18 credits in a suitably selected major area; majors usually are defined by one of the six program areas noted above. The required minor may be satisfied in part by completing a Graduate School minor or by taking the appropriate 15 credits of course work within the department; students must complete an approved project. The Ph.D. comprehensive examination must be taken by the time 70 graduate credits are earned, or prior to the student's fourth year in residency, whichever comes first. The department has no foreign language requirement.

Other Relevant Information

The Department of Psychology makes every effort to recruit and train minority psychologists. Support for minority students is coordinated by the department, the Graduate School Minority Graduate Scholars Award Program, and the American Psychological Association Minority Fellowship Program. In addition,

PSYCHOLOGY

the department often has funded minority students through minority training programs and special minority research programs.

Student Aid

Fellowships, traineeships, graduate assistantships, and other forms of financial aid are described in the STUDENT AID section of the *Graduate Bulletin*.

PSYCHOLOGY (PSY)

- 401. ADVANCED RESEARCH METHODS IN PSYCHOLOGY (3)
- 402. SENSATION AND PERCEPTION (3)
- 404. CONDITIONING AND LEARNING (3)
- 405. THE EXPERIMENTAL PSYCHOLOGY OF VISUAL PERCEPTION (3)
- 407. BEHAVIOR GENETICS (3)
- 408. COMPARATIVE PSYCHOLOGY (3)
- 410. HISTORICAL ANTECEDENTS OF PSYCHOLOGY (3)
- 411. SYSTEMS OF PSYCHOLOGY AND THE RECENT PAST (3)
- 412. ABNORMAL PSYCHOLOGY (3)
- 414. (RL ST) HUMANISTIC, EXISTENTIAL, AND RELIGIOUS APPROACHES TO PSYCHOLOGY (3)
- 415. INTERMEDIATE EXPERIMENTAL DESIGN (3)
- 417. ADVANCED SOCIAL PSYCHOLOGY (3)
- 419. MEASUREMENT AND DECISION MAKING (3)
- 420. (LING) ADVANCED PSYCHOLINGUISTICS (3)
- 421. ADVANCED COGNITIVE PSYCHOLOGY (3)
- 422. VISUAL COGNITION (3)
- 423. COGNITIVE DEVELOPMENT (3)
- 424. SOCIAL AND PERSONALITY DEVELOPMENT (3)
- 425. TOPICS IN DEVELOPMENTAL PSYCHOLOGY (3)
- 426. ADOLESCENCE (3)
- 430. PSYCHOLOGY OF MEMORY (3)
- 432. INTRODUCTORY ENGINEERING PSYCHOLOGY (3)
- 436. MENTAL HEALTH IN SCHOOLS (3)
- 437. PSYCHOLOGY OF ADJUSTMENT (3)
- 438. THEORY OF PERSONALITY (3)
- 441. INDUSTRIAL MOTIVATION AND WORK SATISFACTION (3)
- 444. ATTENTION AND INFORMATION PROCESSING (3)
- 445. (HD FS) DEVELOPMENT THROUGHOUT ADULTHOOD (3)
- 449. INTRODUCTION TO MATHEMATICAL PSYCHOLOGY (3)
- 450. (EDPSY) PRINCIPLES OF MEASUREMENT (3)
- 451. LEADERSHIP IN WORK SETTINGS (3)
- 456. PSYCHOPHYSIOLOGY (3)
- 461. PERSONNEL TESTING AND INTERVIEWING (3)
- 470. SOCIAL LEARNING FOUNDATIONS OF BEHAVIOR CHANGE (3)
- 471. (WMNST) THE PSYCHOLOGY OF GENDER (3)
- 474. PSYCHOLOGY OF EXCEPTIONAL CHILDREN (3)
- 475. SOCIAL PSYCHOLOGY OF INTERPERSONAL/INTERGROUP RELATIONS (3)
- 476. SELF AND SOCIAL JUDGMENT (3)
- 477. APPLIED SOCIAL PSYCHOLOGY (3)
- 479. (RL ST) RELIGION AND CULTURE IN FREUDIAN THOUGHT (3)
- 482. INTRODUCTION TO CLINICAL PSYCHOLOGY (3)
- 483. THE PSYCHOLOGY OF FEAR AND STRESS (3)
- 484. CLINICAL NEUROPSYCHOLOGY (3)
- 485. DEVELOPMENTAL BIOPSYCHOLOGY (3)
- 487. HEALTH PSYCHOLOGY (3)
- 488. THE ANALYTICAL PSYCHOLOGY OF CARL JUNG (3)
- 489. PSYCHOLOGY OF CONSCIOUSNESS (3)
- 494. SENIOR THESIS (3-6)
- 495. PSYCHOLOGY PRACTICUM (1-15)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
- 499. FOREIGN STUDIES (1-12)

501. SEMINAR IN GENERAL PSYCHOLOGY (1) Orientation course for first-year graduate students in Psychology. Prerequisite: graduate standing in the Psychology department.
502. (BB H) HEALTH: BIOBEHAVIORAL PERSPECTIVES (3) Introduction to the role of psychology in maintaining health and in treating nonpsychiatric disorders.
503. HEALTH PSYCHOLOGY SEMINAR (3 per semester, maximum of 12) Seminars in specific areas in health psychology such as anxiety, biofeedback, pain, and stress. Prerequisite: PSY 502.
505. RESEARCH PROBLEMS IN PSYCHOLOGY (1–15) Prerequisites: 12 credits in psychology.
510. HISTORY OF THE HIGHER MENTAL PROCESSES (3) Stress upon theoretical, conceptual, and methodological problems involved in studying human thinking, language, memory, cognition, and other skills. Prerequisite: PSY 410 or 411.
511. SEMINAR IN CONTEMPORARY PSYCHOLOGY (1–9) Critical review of readings on a topic of current interest, either in content or methodology, within psychology. Prerequisites: 9 credits in psychology.
513. (B A, PHIL) PRINCIPLES AND METHODS OF EMPIRICAL SCIENCE (3) Scientific methodologies and their presuppositions, with special emphasis on behavioral and social sciences.
515. ADVANCED STATISTICS IN PSYCHOLOGY AND EDUCATION (3) Correlation theory and methods; discriminant analysis, and factor analysis; applications to mental test theory. Prerequisite: PSY 415 or EDPSY 506.
517. ADVANCED SOCIAL PSYCHOLOGY (3) Problems of theory and of research methods with emphasis on persisting issues relevant to contemporary developments in social psychology. Prerequisites: PSY 417; PSY 015 or STAT 200.
520. (LING) SEMINAR IN PSYCHOLINGUISTICS (3 per semester, maximum of 9) Consideration of theoretical and research issues relevant to psychological aspects of language sounds, syntax and semantics, and other cognitive support.
521. COGNITIVE STUDIES (3) Survey of theories, methods, and issues in cognitive science. Prerequisite: PSY 421.
522. PERSONNEL SELECTION AND APPRAISAL (3) Evaluation of models for personnel selection, placement, and performance appraisal in business and industry. Prerequisites: PSY (EDPSY) 450, PSY 461.
523. SOCIAL-ORGANIZATION PSYCHOLOGY IN INDUSTRY (3) Analysis of the role of social and organizational variables as they affect employee performance and employee attitudes. Prerequisite: PSY 441.
524. PROSEMINAR IN COGNITIVE PSYCHOLOGY (3) An historical introduction to theories and critical findings in the field of cognitive psychology. Prerequisite: graduate standing in the Psychology department.
525. SEMINAR IN COGNITIVE PSYCHOLOGY (3 per semester/maximum of 12) An advanced seminar in a topical or research area in the field of cognitive psychology. Prerequisite: graduate standing in the Psychology department.
526. (HD FS) MEASUREMENT IN HUMAN DEVELOPMENT (3) Principals and methods for assessment of human developmental processes across the life span. Prerequisites: EDPSY 450 or PSY 450; H DEV 516, HD FS 519.
527. STATISTICAL INFERENCE AND EXPERIMENTAL DESIGN (3) Probability theory, sampling distributions, analysis of variance and covariance, analysis of trend, nonparametric statistics, experimental design. Prerequisite: PSY 415 or EDPSY 506.
528. OBSERVATIONAL METHODOLOGIES FOR DEVELOPMENT (3) Design and application of observational methods in developmental research. Prerequisite: graduate student standing in HDFS or psychology.
529. (HD FS) SEMINAR IN CHILD DEVELOPMENT (1–6) Readings and reports on recent findings in child development. Prerequisites: 6 graduate credits in child development, child psychology, or educational psychology, plus 3 in statistics.
531. SEMINAR IN PERFORMANCE THEORY (3–9) Topics in theory and research on human performance in perceptual-motor and information-processing tasks. Prerequisite: PSY 432.
533. ADVANCED ENGINEERING PSYCHOLOGY (3) Analysis of the role of the human operator in man-machine systems. Prerequisite: PSY 432.
534. PRACTICUM IN INDUSTRIAL/ORGANIZATIONAL PSYCHOLOGY (1–3) Supervised application of psychological principles in industrial and governmental settings. Prerequisites: PSY 441, 461.
535. DEVELOPMENTAL PSYCHOLOGY (2–3) Developmental principles and concepts applied to psychological processes, with special reference to the experimental literature. Prerequisites: 9 credits in psychology.

536. (HD FS) RESEARCH METHODS IN DEVELOPMENTAL PROCESSES (3) Methodological issues in research on varying stages of development across the individual life span. Prerequisites: 6 credits in individual development or psychology, and a course in statistics.
538. PSYCHOLOGY OF PERSONNEL DEVELOPMENT (3) Industrial training in relation to psychological learning theory and experimental findings. Prerequisite: PSY 461 or EDPHY 421.
540. SEMINAR IN CLINICAL PROBLEMS (1-9) Contemporary psychological theory, research, and methodology in relation to clinical psychology. Prerequisites: PSY 542, 560.
541. PERSONALITY THEORY (3-4) Contemporary theories of personality; relevant research. Prerequisite: PSY 438.
542. PSYCHOPATHOLOGY (3-4) Theories of pathological behavior with reference to clinical and experimental data. Prerequisite: PSY 412.
543. RESEARCH DESIGN IN CLINICAL PSYCHOLOGY (3) Experimental and quasi-experimental designs, methodological problems, and techniques of experimental control in clinical psychology research. Prerequisite: 3 credits of statistics.
544. PSYCHOLOGICAL HYPNOSIS (3) Theory and research in psychological hypnosis. Techniques in the induction and clinical applications of hypnosis.
549. (HD FS) DEVELOPMENTAL THEORY (3) Conceptual frameworks and major contributions to the study of individual development across the life span. Prerequisites: 6 credits at the 400 level in individual development or psychology.
550. HISTORICAL, THEORETICAL, AND ETHICAL CONSIDERATIONS OF CLINICAL PSYCHOLOGY (2) Survey of the historical, theoretical, and ethical foundations of clinical psychology. Prerequisite: available only to degree candidates in clinical psychology.
554. CLINICAL ASSESSMENT (3) Development of psychological measures; evaluation of reliability and validity. Predictive utility of tests in clinical settings emphasized. Prerequisites: PSY 541 or 542; a course in measurement.
555. THEORY AND PRACTICUM IN CLINICAL ASSESSMENT (3-9) Theoretical issues and research in clinical assessment with special reference to administration and interpretation of testing procedures and clinical interviewing. Prerequisites: PSY 541 or 542, and a course in measurement.
556. NEUROPSYCHOLOGICAL ASSESSMENT (4) Survey of human neuroanatomy, neuropathology, behavioral correlates of cerebral dysfunction, and the assessment of neurological disorders. Prerequisite: PSY 484, 554.
557. INTRODUCTION TO PSYCHOPHARMACOLOGY AND SURVEY OF BIOLOGICAL THERAPIES (3) An introduction to the principles of psychopharmacology and to the medications used to treat psychopathologies. Prerequisite: PSY 542, graduate standing in Psychology (Clinical, Counseling, or School).
559. (S PSY) THE INDIVIDUAL PSYCHOLOGICAL EXAMINATION (3) Demonstrations and practice in widely used ability and aptitude tests; psychological report writing. Prerequisites: 15 credits in psychology and a course in measurement.
560. PRACTICUM IN CLINICAL METHODS (1-6) Supervised practice in the Psychology Clinic, including assessment, therapy, report writing, and staff participation. Prerequisite: PSY 555.
561. CLINICAL PRACTICUM WITH CHILDREN (1-6) Diagnosis and counseling of child-parent problems of learning and adjustment. Prerequisites: PSY 425, 426, 555.
563. BEHAVIOR MODIFICATION I (3) Conceptual foundations of principles, assessment methods, and research strategies.
564. BEHAVIOR MODIFICATION II (3) Survey and empirical evaluation of treatment strategies. Prerequisite: PSY 563.
565. SEMINAR IN COMMUNITY PSYCHOLOGY (3) Application of social psychological research methods and principles to prevention and alleviation of behavior disorders in family and community settings.
566. CULTURAL PSYCHOLOGY (3) Experimental and descriptive research on culture and behavior in both Western and non-Western settings. Prerequisites: PSY 417, 438, and 6 credits in statistics.
569. ADVANCED THEORY AND PRACTICUM IN COUNSELING AND PSYCHOTHERAPY (3-9) Theoretical issues, research, and practicum experience in psychotherapy.
571. SEMINAR IN SOCIAL PSYCHOLOGY (3-9) Historical development of theory and methods; determinants and principles of complex social or interactional behavior; contemporary problems and research.
575. CLINICAL CHILD PSYCHOPATHOLOGY (3) Overview of developmental clinical child psychopathology; emphasis on social-emotional development, with review of abnormal development and social-emotional maladjustment. Prerequisite: graduate standing in clinical psychology or 18 credits of graduate course work in psychology, HD FS, or a related field.

576. **CLINICAL CHILD INTERVENTIONS** (3) Clinical-child therapeutic techniques from a developmental-clinical perspective with emphasis on theoretical basis and empirical evaluation of various techniques. Prerequisite: PSY 575.

577. **CLINICAL CHILD ASSESSMENT** (3) Overview of major methods used in clinical assessment of infants, preschool children, and grade-school children with emphasis on social-emotional functioning. Prerequisite: PSY 559, 575, or background in psychological assessment.

583. **DESIGNING RESEARCH IN SOCIAL PSYCHOLOGY** (3) Designs and procedures useful in social psychology and cognate disciplines; quasi-experimental designs and analysis, field experimentation, validity of inferences. Prerequisite: 3 credits of 500-level statistics.

584. **(SOC) ATTITUDE FORMATION AND CHANGE** (3) Theory and method in research on attitude formation and change with emphasis on critical analysis. Prerequisites: PSY 417 or SOC 403; 3 credits in statistics.

585. **(SOC) INTERACTION PROCESSES WITHIN AND BETWEEN GROUPS** (3) Interactions in personal, group, and intergroup relations; theory and observational methods. Prerequisite: PSY 417 or SOC 403.

587. **(SOC) SOCIALIZATION** (3) Behavioral, cognitive, developmental, symbolic, interactionist, and role theories of socialization; emphasis on current theory and research. Prerequisite: PSY 417 or SOC 403.

588. **(SOC) THE SOCIAL ORGANIZATION OF ATTRIBUTION** (3) Principles of attribution and their relevance to such topics as power relations, authority, equity, injustice, and social movements. Prerequisite: PSY 417 or SOC 403.

589. **SOCIAL COGNITION AND SOCIAL PERCEPTION** (3) Overview of how social behavior and social perception (e.g., impression formation, attitudes, the self, stereotyping) are influenced by cognitive processes.

590. **COLLOQUIUM** (1-3)

591. **SEMINAR ON TEACHING PSYCHOLOGY** (1-3) Objectives and content of psychology; organization and presentation of material; teaching aids and techniques.

596. **INDIVIDUAL STUDIES** (1-9)

597. **SPECIAL TOPICS** (1-9)

PUBLIC ADMINISTRATION (P ADM)

JEREMY F. PLANT, *MPA Coordinator*

RUPERT F. CHISHOLM, *Ph.D./MPA Coordinator*

Penn State Harrisburg

777 W. Harrisburg Pike

W-160 Olmsted Building

Middletown, PA 17057

Degrees Conferred: M.P.A., Ph.D.

The Core Graduate Faculty

J. Marvin Bentley, Ph.D. (Tulane) *Associate Professor of Economics*

Rupert F. Chisholm, Ph.D. (Case Western Reserve) *Associate Professor of Management*

Beverly A. Cigler, Ph.D. (Penn State) *Professor of Public Policy and Administration*

Cynthia Zelff Massie Mara, Ph.D. (VPI) *Assistant Professor of Health Care Administration and Policy*

Christopher K. McKenna, Ph.D. (NYU) *Associate Professor of Management Science*

Robert F. Munzenrider, Ph.D. (Georgia) *Associate Professor of Public Administration*

Jeremy F. Plant, Ph.D. *Professor of Public Administration and Public Policy*

Jack Rabin, Ph.D. (Georgia) *Professor of Public Administration and Public Policy*

James E. Skok, Ph.D. (Maryland) *Associate Professor of Public Administration*

James T. Ziegenfuss, Jr., Ph.D. (Pennsylvania) *Professor of Management and Health Care Systems*

M.P.A. Program

The Master of Public Administration (MPA) program is intended for those with career interests in public management, health and human services, government, and other public service and nonprofit organizations. The curriculum blends theoretical and applied concepts and assures "real-world" experiences for the novice administrator. In addition, it requires that students devote attention to general professional development. The MPA program is accredited by the National Association of Schools of Public Affairs and Administration.

FULL-TIME OR PART-TIME—Students may begin the program in any semester. Three courses (or 9 credits) per semester are considered a normal course load for full-time students. Part-time students typically take one or two 3-credit courses each semester and one or two courses during the summer session to maintain steady progress toward the degree. The program, including an internship in a public agency or nonprofit organization, requires 18- to 24-months of full-time study, or 3 to 5 years on a part-time basis.

Admission Requirements

Applicants must have received their baccalaureate degree from an accredited college or university prior to starting the graduate program. Applicants who are still completing their baccalaureate requirements at the time of application may be admitted to the Graduate School conditional on the awarding of the baccalaureate degree.

Admission to the M.P.A. program is based on clear suitability for the program as demonstrated by the application as a whole, including the following: a completed application with the application fee; evidence of a bachelor's degree from an accredited college; a statement of career and educational goals; a successful undergraduate record with a grade-point average of 3.00 (either as the cumulative GPA or for the last 60 hours of relevant course work); satisfactory scores on the Graduate Record Examination (GRE), Graduate Management Admission Test (GMAT), or Law School Admission Test (LSAT) if the GPA is less than 3.0; and three references willing to provide recommendations.

Prerequisites

All students admitted to the MPA program must show prerequisite 3-credit course work in statistics and statistical software with a satisfactory grade. Students without prior course work in statistics must fulfill this prerequisite within two semesters of admission. Credits earned do not count toward the MPA requirement.

Degree Requirements

The M.P.A. degree program requires 36 graduate credits—18 in core courses, 15 in electives, and 3 for the master's project. Up to 6 credits of 400-level courses may be taken as electives, with the approval of an advisor. In addition, a 9-credit internship is required of students who do not have at least three years of full-time relevant work experience, which consists of supervisory, managerial, or professional work. The internship is waived for students with this experience before they enter the program or who gain it during the program.

REQUIRED CORE COURSES (18 credits)

P ADM 500, 501, 502, 503, 506, 510

ELECTIVE CONCENTRATION AREA (15 credits)

With the faculty adviser's approval, a student selects 15 credits of electives. Concentrations offered are Government Administration, Health Care Management and policy, and Human Resources Management, Information Resource Management, and Criminal Justice, as well as the general public administration degree.

Examples of suitable elective courses: P ADM 505, 511, 512, 514, 515, 516, 522, 523, 524, 531, 532, 533, 534, 550, 556, 557, 558, 561, 562, 563, 564, and 565. Courses listed under the Master of Health Administration program may also be taken: H ADM 539, 540, 541, 542, 543, 545, 546, 548, 551, 552.

MASTER'S PROJECT—P ADM 594

INTERNSHIP IN PUBLIC ADMINISTRATION—P ADM 595 (if required)

Ph.D. Program

The Doctor of Philosophy in Public Administration provides a broad-based academic program combining conceptual foundations with research and analytical skills. The goal of the program is to improve public, nonprofit, and related organizations through the creation of "scholar/practitioner"—professionals with the ability to create and apply knowledge through teaching, research, consulting, and management.

Graduates of the program can prepare to: conduct research, advancing knowledge in the field; apply theory to public and nonprofit organizations; analyze and evaluate public policy, improve policy implementation through effective public management, and develop more effective public and nonprofit organizations.

PART-TIME OR FULL-TIME PROGRAM—The program is unique in that it provides full-time working professionals with the opportunity to complete the program on a part-time basis. The program also admits a limited number of full-time students. Part-time students can complete the program in approximately seven years of continuous study. This time may be condensed or expanded depending on the number of courses taken each semester and prior academic work completed by the student.

Admission Requirements

Students may apply for admission at any time. Admitted students who have met all course prerequisites begin the core courses with PADM 570—Scope and Methods of Public Administration in the fall. Students admitted after August 15 or those requiring prerequisites will take elective or prerequisite courses until the following fall semester begins.

Applicants for the Doctor of Philosophy in Public Administration should hold a master's degree in public administration, public policy, or a related field such as business, economics, political science, or social science. However, applicants with master's degrees in other fields also will be considered. In addition, the applicant should have five years of professional work experience.

Students are required to submit the following: a completed application with the application fee; two transcripts of all undergraduate and graduate course work; scores from the Graduate Record Examination (GRE); three letters of reference attesting to both academic and professional capabilities (At least two of these letters should be from academic sources, such as prior professors or academic advisers.); a letter of approximately 500 words outlining significant work experience, career goals, and academic objectives; and a recent personal vita.

Degree Requirements

Students progress through the following phases and take the required courses indicated as part of their study for the Ph.D.

Precandidacy—In this phase, the student must (1) make up any deficiencies in graduate courses in public administration noted in the letter of acceptance, (2) complete P ADM 570 (Scope and Methods), P ADM 575 (Research Design), and at least one course from the P ADM 571–574 seminar series, with an average of 3.5 or better, and (3) pass a preliminary exam.

Candidacy—Candidates take additional course work to prepare for comprehensive examinations in three subfields of study, complete a period of residency, and write the Ph.D. dissertation. The five subfields of specialization are: organization theory and behavior, political institutions, policy analysis, public management, health care management and policy. Additional subfields of study from disciplines other than public administration may be selected with the approval of the student's doctoral committee.

Residency—A period of two consecutive semesters of concentrated study and research as a full-time student—9 credits per semester.

The Dissertation—Under guidance from the dissertation committee, the candidate prepares a detailed research proposal that serves as the basis for the written dissertation. The writing and defense of this original contribution to the theory of public administration is the capstone to the Ph.D. program.

PUBLIC ADMINISTRATION (P ADM)

486. APPLIED STATISTICAL PACKAGES (1)

500. PUBLIC ORGANIZATION AND MANAGEMENT (3) Development of public administration; administrative theory and practice in public organizations.

501. ADMINISTRATION AND THE POLITICAL PROCESS (3) Analysis of the relationship of administration to the political processes that shape public policy formulation and execution. Prerequisites: 3 credits in American government, 3 credits in micro/macro economics.

502. GOVERNMENTAL FISCAL DECISION MAKING (3) Nature, function, and techniques of governmental budgeting viewed as mechanism for allocating resources among alternative public uses. Prerequisites: P ADM 500, 501, or permission of program.

503. (H ADM, UR PL) RESEARCH METHODS (1–3) Examination of research methodologies relevant to administration, planning, and public policy. Prerequisite: SCLSC 320. Concurrent: P ADM 486.

505. PERSONNEL MANAGEMENT: PUBLIC AND NONPROFIT SECTOR (3) Concepts and approaches contributing to effective use of human resources in public and nonprofit organizations; legal issues and requirements. Prerequisites: P ADM 500, 510.
506. (H ADM) MANAGEMENT INFORMATION SYSTEMS FOR PUBLIC AND HEALTH ADMINISTRATION (3) The design, implementation, and purpose of computerized management information systems in public and nonprofit organizations. Prerequisite: any course requiring the use of a computer.
510. (H ADM) ORGANIZATIONAL BEHAVIOR (3) Examination of concepts of human behavior in formal organizations, systems analysis, conceptual models, and decision processes. Prerequisite: permission of program.
511. ORGANIZATIONAL CHANGE AND DEVELOPMENT (3) Theory of organizational change and development; case analysis of applications in actual situations. Prerequisites: P ADM 510 or MNGMT 510.
512. ISSUES IN HUMAN RESOURCES (3) A survey of major human resource issues such as job stress, burnout, and the many forms of discrimination in organizations. Prerequisites: P ADM 505, 510.
514. PUBLIC ORGANIZATION AND MANAGERIAL CONSULTATION (3) This course will review the theories, approaches, methods, and expected outcome of organization and management consultation. Prerequisite: P ADM 500 or 510.
515. LABOR MANAGEMENT RELATIONS (3) Labor relations issues; collective bargaining agreement, negotiations, and administration; legal framework of collective bargaining; labor relations in larger social context.
516. STRATEGIC PLANNING (3) A survey of strategic planning purposes, approaches, and methods, and expected outcomes in small and large organizations. Prerequisite: P ADM 500.
522. GOVERNMENT FINANCIAL MANAGEMENT (3) Theories and techniques of financial planning and control, with emphasis on their application in government and nonprofit agencies. Prerequisites: P ADM 502, 3 credits in accounting.
523. GOVERNMENTAL AND NONPROFIT ACCOUNTING (3) Accounting, reporting, and auditing principles and procedures for public sector agencies and nonprofit organizations.
524. ADMINISTRATIVE LAW (3) Statutory and judicial controls upon administrative discretion. Administration of rule making, rate setting, licensing, adjudication. Judicial review and citizen advocacy. Prerequisites: P ADM 500, 501.
531. ENVIRONMENTAL POLICY (3) The course examines environmental and natural resources policies at every level of U.S. government and internationally.
532. URBAN GOVERNMENT (3) Administrative processes and policy problems associated with managing urban communities; political, intergovernmental, fiscal, structural, and analytical concepts in urban government.
533. LOCAL PLANNING LAW AND ADMINISTRATION (3) Structure and function of local and regional government from perspective of local planning law and its administration.
534. MANAGING ECONOMIC DEVELOPMENT (3) Theoretical and operational aspects of economic development emphasizing the role of local and regional government. Prerequisite: principles of economics.
550. PROGRAM PLANNING AND EVALUATION (3) Analysis and evaluation of public programs and systems from the perspectives of policy development and administrative planning and management. Prerequisite: P ADM 503 or permission of instructor.
554. MASTER'S PROJECT (1-3) Student independently executes an applied professional or research project involving the analysis of a management or a public policy problem. Prerequisite: P ADM 503.
556. STATE GOVERNMENT ADMINISTRATION (3) Study of structures, systems, processes, problems, and issues affecting state government administration; case studies, field observations, and research. Prerequisites: P ADM 500, 501.
557. FEDERALISM AND INTERGOVERNMENTAL RELATIONS (3) Study of the impact of a federal system of government on the administration of public functions. National-state-local dimensions. Prerequisites: P ADM 500, 501.
558. LEGISLATIVE PROCESSES (3) Legislatures in American government, emphasizing comparative state legislatures: constitutional patterns; organization, administration; interaction with bureaucracy, constituencies, and organized interests. Prerequisites: P ADM 500, 501.
561. THE CRIMINAL JUSTICE SYSTEM IN AMERICA (3) Provides a critical analysis of the U.S. criminal justice system.
562. CONTEMPORARY ISSUES IN CRIMINAL JUSTICE (3) Research-based inquiry into critical contemporary issues in criminal justice.
563. CONCEPTS AND PRACTICES IN POLICE ADMINISTRATION (3) Discusses application of police research and management principles to the contemporary policing context.

564. ADMINISTRATIVE AND LEGAL ASPECTS OF CORRECTIONS (3) This course addresses historical and contemporary correctional policy, accountability and possible remedial alternatives.
565. COURTS IN THE CRIMINAL JUSTICE SYSTEM (3) An analysis of the function and role of the courts with the personnel involved in the American criminal justice system.
570. SCOPE AND METHODS OF PUBLIC ADMINISTRATION (3) Examination of theoretical approaches to Public Administration and the role of theory in the field. Prerequisites: P ADM 500, 501, 502, 503, 504, 510.
571. SEMINAR IN ORGANIZATION THEORY (3) Selected theories of organizations and their applications to the study of public organizations. Prerequisite: P ADM 570.
572. RESEARCH AND THEORY IN POLITICAL INSTITUTIONS (3) Selected research paradigms and their application in the study of political institutions. Prerequisite: P ADM 570.
573. RESEARCH AND THEORY IN POLICY ANALYSIS (3) The five major modes of policy inquiry, the analytic methodologies associated with each, and their applications to real world problems. Prerequisite: P ADM 570.
574. RESEARCH AND THEORY IN PUBLIC MANAGEMENT (1) Theoretical and empirical bases for selected functions of public managers. Prerequisite: P ADM 570.
575. ADVANCED RESEARCH DESIGN (3) Experimental, quasi-experimental, survey, aggregate, and other research designs applied to organizational, managerial, and policy analysis research problems. Prerequisite: P ADM 570.
576. MULTIVARIATE STATISTICAL METHODS (3) Multivariate statistical methods, with special emphasis on their use in organizational, managerial, and policy analysis research settings. Prerequisite: P ADM 575.
590. COLLOQUIUM (1-3)
591. READINGS IN PUBLIC ADMINISTRATION (3) Directed readings in selected areas of public administration. Prerequisite: P ADM 570 and permission of program.
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

PUBLIC ADMINISTRATION, JURIS DOCTOR AND MASTER OF (J.D./M.P.A.)

JEREMY F. PLANT, *Program Coordinator*
 Penn State Harrisburg
 777 W. Harrisburg Pike
 Middletown, PA 17057-4898
 Tel. (717) 948-6050

Degrees conferred: J.D./M.P.A.

The Dickinson School of Law of The Pennsylvania State University and the School of Public Affairs of Penn State Harrisburg, the Capital College, offer a cooperative program leading to the degrees of Juris Doctor, to be granted by Dickinson, and Master of Public Administration, to be granted by Penn State Harrisburg.

Admission Requirements

In order to be admitted to the program, students must first be admitted to The Dickinson School of Law under its regular admission procedures. Dickinson need not forward applications of all DSL admittees who have expressed interest in the MPA program and can withhold support for some admittees until they have demonstrated proficiency in their legal studies and a capacity for dual degree study. Penn State Harrisburg will make independent admissions decisions as to all dual degree applicants.

The Dickinson Admissions Office requires: application forms for DSL and PSH Graduate School, the Law School Admission Test (LSAT), a completed LSDAS report, a one-page personal statement, employment record since high school, and two recommendations.

The Penn State Harrisburg Admissions Office requires: completed applications (Graduate School and MPA), with the application fee; evidence of a bachelor's degree from an accredited college; a statement of career and educational goals; a successful undergraduate record with a grade-point average of 3.0 (either as the cumulative GPA or for the last 60 hours of relevant course work); satisfactory scores on the Graduate Record Examination (GRE), Graduate Management Admission Test (GMAT), or Law School Admission

Test (LSAT) if junior-senior or cumulative GPA is less than 3.0); and three names of references willing to provide recommendations.

Prerequisites

All students admitted to the MPA program must show prerequisite course work in statistics and statistical software with a satisfactory grade. Students without prior course work in statistics must fulfill this prerequisite within two semesters of admission. Credits earned do not count toward the J.D./M.P.A. degree.

Degree Requirements

To be eligible to earn the Juris Doctor degree, a candidate must: earn credit for 88 semester hours of course work, have a cumulative average of at least 70.00, complete all required courses (currently totaling 41 semester hours) plus at least one seminar, and complete six semesters in residence.

The MPA degree program requires 36 graduate credits—18 in core courses, 15 in electives, and 3 for the Master's Project.

A maximum of 9 credits for Dickinson School of Law course work may be transferred for credit toward the MPA degree at Penn State Harrisburg, subject to Harrisburg's approval based on relevance to the MPA program.

A maximum of 9 credits for MPA course work with a grade of B or better may be transferred for credit toward the J.D. degree at Dickinson. Courses for which such credit may be applied shall be subject to approval by the Dickinson faculty.

It is anticipated that students will complete a minimum of 79 credits from Dickinson and 27 credits (not including the internship) from Penn State Harrisburg in order to earn the J.D. and M.P.A. degrees. A student in the program, however, may obtain either degree prior to completing all requirements for the other degree. Students must earn at least a 3.0 grade-point average to be eligible for the M.P.A. degree.

Matrix of Courses in the Dickinson School of Law/ Penn State Harrisburg Cooperative J.D./M.P.A. Program

Dickinson School of Law

Civil Procedure I, II (2,2)	Appellate Moot Court (1)
Contracts I, II (3,2)	Secured Transactions (2)
Lawyering Skills I, II (2,2)	Basic Federal Taxation (3)
Criminal Procedures (3)	Evidence (3)
Criminal Law (2)	Professional Responsibility (2)
Torts I, II (3,2)	Constitutional Law (3)
Property I, II (2,3)	Electives (38)

Internship requirements to be met with activity jointly approved by Dickinson and Penn State Harrisburg faculty. Credits are Dickinson, and not transferred to Penn State Harrisburg.

Credits earned at Dickinson School of Law—79

Credits transferred from Penn State Harrisburg—9

Total credits required for J.D.—88

Penn State Harrisburg

P ADM 500	Public Organization and Management (3)
P ADM 501	Administration and the Political Process (3)
P ADM 502	Government Fiscal Decision Making (3)
P ADM 503	Research Methods (3)
P ADM 506	Management Information Systems (3)
P ADM 510	Organizational Behavior (3)
P ADM 594	Research in Public Administration (3)

Electives (6)

Credits earned at Penn State Harrisburg—27

Credits transferred from Dickinson School of Law—9

Total credits required for M.P.A.—36

See PUBLIC ADMINISTRATION (P ADM) (M.P.A.) for list of courses available as electives.

QUALITY AND MANUFACTURING MANAGEMENT (QMM)

MICHAEL P. HOTTENSTEIN, *Professor of Operations Management*
 CLAYTON O. RUUD, *Professor of Industrial Engineering*
 111 Hallowell Building
 814-863-5802

Degree Conferred: M.M.M.

This graduate program is designed to prepare students for careers in manufacturing management. This integrated, interdisciplinary program in quality and manufacturing management is offered jointly by The Smeal College of Business Administration and the College of Engineering. The program is offered on a full-time basis only and requires nine months of continuous study during a normal academic year. An appropriate internship experience is a precondition for entrance to the program. Students take 30 credits of work in ten core courses. The objective of the program is to develop managers who will lead manufacturing firms in the twenty-first century. Graduates from the program would be able to: span engineering and business specialties in order to integrate skills pertinent to customer-oriented approaches to manufacturing; work with customers in product design, development, and manufacturing; address problems that merge business and technical issues; and understand and champion process improvement across the organization and with suppliers and customers.

Admission Requirements

The program draws its students from two groups: practicing engineers and other professionals from industry and undergraduate students currently enrolled in undergraduate programs in business administration, engineering, and science.

Applicants from industry must have a minimum of one year of relevant industry work experience, must have received a baccalaureate degree in physical science, engineering, business, or management from an accredited university, and must submit scores from the Graduate Record Examination (GRE) or the Graduate Management Admission Test (GMAT).

Applicants who are currently enrolled as undergraduates should apply for admission to the program in their senior year. They can be enrolled in any major in engineering, science, or business administration. Applicants who are not enrolled at Penn State or who have not graduated from Penn State within the last academic year at the time of applying, must submit GRE or GMAT scores. At the time of application for admission, they should have a minimum cumulative grade-point average of 3.0, and before admission must complete an appropriate three-month internship.

All applicants must complete the following prerequisites or the equivalent before they may matriculate: MATH 140 and 141, STAT 200 or MS&IS 200, CMPSC 201 or 203.

Degree Requirements

The QMM degree requires 30 credits of graduate work on a full-time basis. The courses are as follows: QMM 491 or 492; 551, 552, 561, 562, 571, 572, 581, 582, 597.

The program director or co-directors are authorized to make suitable substitutions in the above curriculum in consultation with the faculty steering committee.

Student Aid

A limited number of partial scholarships are available for students in the program.

QUALITY AND MANUFACTURING MANAGEMENT (QMM)

491. INTRODUCTION TO BUSINESS CONCEPTS FOR MANUFACTURING (3)

492. INTRODUCTION TO ENGINEERING DESIGN PRINCIPLES (3)

551. QUALITY MANAGEMENT (3) Concepts of design, assessment, and improvement of quality systems; customer needs analysis, identification of opportunities for application of measurement techniques.

552. APPLIED STATISTICAL PROCESS CONTROL AND EXPERIMENTAL DESIGN (3) Concepts and techniques of statistical process control and the design of experiments. Prerequisite: QMM 551.

561. MANUFACTURING SYSTEMS PLANNING AND CONTROL I (3) Systems, components and configurations, flow of material and information in a manufacturing system. Prerequisite: admission to the QMM program.

562. MANUFACTURING SYSTEMS PLANNING AND CONTROL II (3) Flow of material and information in a manufacturing system; emphasis on systems integration. Prerequisite: QMM 561.
571. DESIGN PRACTICE FOR MANUFACTURING I (3) Contemporary concepts in design and design practice with emphasis on engineering, business, and human strategy issues. Prerequisite or concurrent: QMM 491 or 492.
572. DESIGN PRACTICE FOR MANUFACTURING II (3) Contemporary concepts in design and design practice with emphasis on logistics, risk, design and manufacturing readiness, and production. Prerequisite: QMM 571.
581. MANUFACTURING PROCESSES AND MATERIALS (3) Characteristics of materials with respect to their properties and associated choices of processing to create a range of products. Prerequisite: admission to the QMM program.
582. MANUFACTURING STRATEGY AND ORGANIZATION (3) Strategic decision context of manufacturing and linkage with corporate and business strategy; includes cost drivers, organizational structure and human relations. Prerequisite: enrollment in the QMM program.
597. COMMUNICATION AND LEADERSHIP SKILLS FOR MANAGERS (3) Applied principles of oral, interpersonal, group, presentational communication; visual design; business and technical written communications; and organizational leadership.

RURAL SOCIOLOGY (R SOC)

DAVID BLANDFORD, *Head of the Department of Agricultural Economics and Rural Sociology*
103 Armsby Building
814-865-5461

Degrees Conferred: Ph.D., M.S., M.Agr.

The Graduate Faculty

Gretchen T. Cornwell, Ph.D. (Penn State) *Assistant Professor of Rural Sociology*
Daryl K. Heasley, Ph.D. (Penn State) *Associate Professor of Rural Sociology Extension*
Drew W. Hyman, Ph.D. (California) *Professor of Public Policy and Community Systems*
Leif I. Jensen, Ph.D. (Wisconsin) *Associate Professor of Rural Sociology*
Stanford M. Lembeck, Ph.D. (Penn State) *Professor of Rural Sociology*
Albert E. Luloff, Ph.D. (Penn State) *Professor of Rural Sociology*
Diane K. McLaughlin, Ph.D. (Penn State) *Assistant Professor of Rural Sociology*
Kenneth E. Martin, Ph.D. (Penn State) *Senior Research Associate*
Carolyn E. Sachs, Ph.D. (Kentucky) *Associate Professor of Rural Sociology*
C. Shannon Stokes, Ph.D. (Kentucky) *Professor of Rural Sociology*
Joan S. Thomson, Ph.D. (Wisconsin) *Associate Professor of Rural Sociology Extension*
James Van Horn, Ph.D. (Ohio State) *Professor of Rural Sociology Extension*
Rex H. Warland, Ph.D. (Iowa State) *Professor of Rural Sociology*
Fern K. Willits, Ph.D. (Penn State) *Professor of Rural Sociology*

All degree programs emphasize a comprehensive understanding of the various facets of societal organization pertinent to the rural sector. While breadth is encouraged, areas of special interest and research include food choice, instigated social change, community structure, leadership, population, rural health, rural community services, the structure of agriculture, and the ecology of rurality in industrialized and urbanized society.

Admission Requirements

Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Prerequisites for the master's program include 3 credits in rural sociology, and additional credits in either field. If the entering student does not have these prerequisites, they must be made up at the University during the early part of the master's program.

Students with a 3.00 junior/senior average (on a 4.00 scale) and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that

are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

Degree Requirements

All students are required to have training in sociological theory, statistics, and research methods.

There is no foreign language requirement for the Ph.D. degree; the student is expected to substitute such courses and instruction necessary to generate superior capabilities of inquiry into an analysis of basic and/or applied rural sociological problems.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

RURAL SOCIOLOGY (R SOC)

- 402. CONSUMER BEHAVIOR AND AGRICULTURAL BUSINESS (3)
- 417. POWER, CONFLICT, AND COMMUNITY DECISION MAKING (3)
- 420. (WMNST) WOMEN IN DEVELOPING COUNTRIES (3)
- 422. FAMILY IN RURAL SOCIETY (3)
- 425. POVERTY ANALYSIS: PEOPLE AND PROGRAMS (3)
- 444. SOCIAL CHANGE IN RURAL AMERICA (3)
- 452. RURAL ORGANIZATION (3)
- 460. INTRODUCTION TO COMMUNITY INFORMATION SYSTEMS (3)
- 462. COMMUNITY INFORMATION SYSTEMS LABORATORY (3)
- 470. COMPARATIVE COMMUNITY DEVELOPMENT (3)
- 496. INDEPENDENT STUDIES (1–18)
- 497. SPECIAL TOPICS (1–9)
- 499. FOREIGN STUDY—RURAL SOCIETY (1–12)

- 501. DEVELOPMENT OF RURAL SOCIOLOGY (3) Historical development with emphasis on American rural sociology. Odd years.
- 502. USE OF THEORY IN RURAL SOCIOLOGY (3) Examine and evaluate metasociology of alternative theoretical systems applicable to rural society, with emphasis on American society. Prerequisites: 24 credits in sociology, including 6 in rural sociology and 3 in sociological theory.
- 505. LEADERSHIP DEVELOPMENT (3) Exploration, understanding, and application of leadership roles, strategies, and principles in group and community settings. Prerequisites: R SOC 305W; 6 credits in social or behavioral sciences.
- 508. SOCIOLOGY OF AGRICULTURE (3) Sociological analysis of changes in the organization of agriculture and food systems in the United States and developing countries.
- 515. (EXTED) THE COOPERATIVE EXTENSION ORGANIZATION (3) The Cooperative Extension Service as a social system, with emphasis on techniques of organization and program development. Prerequisites: 9 credits in education, communication, and/or social sciences.
- 516. CHANGE IN RURAL SOCIETY (3) Social change in rural society, emphasizing prediction and control of the change process. Even years.
- 517. INTERNATIONAL RURAL SOCIAL CHANGE (3) Implications of planned change for international rural societies, considering basic structural constraints, known institutional linkages, and potential synergetic consequences.
- 520. (SOC) APPLIED SOCIOLOGICAL AND POLICY RESEARCH (3) Survey of the conceptual and methodological issues in applied sociology and policy research conducted by sociologists. Prerequisite: SOC 574.
- 522. DATA ANALYSIS IN RURAL SOCIOLOGY (1) Analysis of research data in rural sociology using computer library programs. Prerequisite or concurrent: AG 400.
- 525. FERTILITY, POPULATION CHANGE, AND DEVELOPMENT (3) Fertility and population growth in less-developed countries; theories of fertility change, agricultural development, and population policies. Prerequisite: SOC 423 or prior work in population.
- 530. SOCIOLOGY AND DEMOGRAPHY OF POVERTY IN THE UNITED STATES (3) An in-depth treatment of sociological and demographic dimensions of poverty in rural and urban areas of the United States.
- 555. (S T S) HUMAN DIMENSIONS OF NATURAL RESOURCES (3) Identification of the interrelationships and influence of human behavior and natural resources.
- 573. METHODS OF SURVEY DATA ANALYSIS (3) Use of multivariate procedures in the analysis of survey data in the rural social sciences. Prerequisite: AG 400.

RUSSIAN AND COMPARATIVE LITERATURE

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

RUSSIAN AND COMPARATIVE LITERATURE

MICHAEL M. NAYDAN, *Director, Program in Slavic and East European Languages in the Department of Germanic and Slavic Languages and Literatures*

303 Burrowes Building

814-865-1675

CAROLINE D. ECKHARDT, *Head, Department of Comparative Literature*

311 Burrowes Building

814-863-0589

Degree Conferred: M.A. in Russian and Comparative Literature

The Department of Germanic and Slavic Languages and Literatures and the Department of Comparative Literature offer a joint master's degree in Russian and Comparative Literature. The program enables students to concentrate in Russian literature at the graduate level while having the advantages of a comparative context. Students completing this M.A. will acquire an in-depth understanding of Russian literature and culture and will be proficient in Russian and one other foreign language. Graduates should be prepared for service with the U.S. government or an international corporation, or to continue graduate study either in Russian or comparative literature.

Admission Requirements

Requirements listed here are in addition to the general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*. Students with appropriate course backgrounds and a 3.00 junior/senior average (on a 4.00 scale) will be considered for admission. Scores from the Graduate Record Examination (GRE) are required. It is expected that students entering this degree program will have proficiency in Russian language and will have completed the B.A. in Russian or Comparative Literature. Students in other humanistic fields such as philosophy or history who have studied some literature and are proficient in Russian are welcome to apply.

Master's Degree Requirements

Candidates for the M.A. degree must earn a minimum of 33 credits of which at least 18 must be at the 500 level. Required courses in Russian include RUS 530 (Seminar in Nineteenth-Century Russian Literature), RUS 525 (Pushkin), and RUS 560 (History of the Russian Language) or RUS 542 (Seminar in Russian Literature in the Twentieth Century) plus an additional 6 credits. Required courses in comparative literature include CMLIT 501 plus an additional 12 credits in comparative literature. Also required are an additional 3 credits in Russian, comparative literature, or another approved area; passing of a proficiency examination in Russian; demonstration of reading knowledge of one other foreign language; and the completion of an acceptable M.A. paper.

Student Aid

There are a number of teaching assistantships in the Departments of Comparative Literature and Germanic and Slavic Languages and Literatures for students taking advanced degrees in these disciplines. There is also a graduate assistant position for an editorial assistant. See also the fellowships, graduate assistantships, and other forms of financial aid described in the STUDENT AID section of the *Graduate Bulletin*

SCHOOL PSYCHOLOGY (S PSY)

ROBERT L. HALE, *Head, Department of Educational and School Psychology and Special Education*

227 CEDAR Building

814-865-6072

MARLEY W. WATKINS, *In Charge of Graduate Programs in School Psychology*
 102 CEDAR Building
 814-863-2419

Degrees Conferred: Ph.D., M.S., M.Ed.

The Graduate Faculty

Keith A. Crnic, Ph.D. (Washington) *Professor of Psychology*
 Joseph L. French, Ed.D. (Nebraska) *Professor Emeritus of Education*
 Robert L. Hale, Ph.D. (Nebraska) *Professor of Education*
 Donald B. Keat II, Ph.D. (Temple) *Professor of Education*
 Ronald A. Madle, Ph.D. (Penn State) *Adjunct Associate Professor of Education*
 Bonnie J. F. Meyer, Ph.D. (Cornell) *Professor of Educational Psychology*
 Mary Ellen Sabatino, D.Ed. (Penn State) *Adjunct Assistant Professor of Education*
 Barbara A. Schaefer, Ph.D. (Pennsylvania) *Assistant Professor of Education*
 John Salvia, D.Ed. (Penn State) *Professor of Special Education*
 Marley W. Watkins, Ph.D. (Nebraska) *Associate Professor of Education*
 Frank C. Worrell (California at Berkeley) Ph.D. *Assistant Professor of Education*

This intercollege program is based primarily on courses in educational psychology, psychology, and special education. In addition, courses are often drawn from counselor education, human development and family studies, educational theory and policy, educational administration, and curriculum and instruction. The objective is to develop a psychologist capable of providing health care who is interested in and knowledgeable about education and psychology in the school setting. The school psychologist must utilize professional skill and knowledge about children and youth to make contributions that are meaningful to and utilized by teachers, other school personnel, and parents. The development of competencies needed by a fully qualified school psychologist requires at least the education represented by a doctoral degree.

Practicum facilities, in addition to those in nearby public schools, include the Center for Educational Diagnosis and Remediation, the School Psychology Clinic, the Communication Disorders Clinic, the Reading Center, and the Psychology Clinic. Facilities for work with children are also available through other academic units, as well as through assistantship assignments.

Admission Requirements

Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Only those students who anticipate a doctoral degree will be admitted. Students are selected within the limitations of program facilities. Priority is given to applicants with work experience with children.

An undergraduate major emphasizing work in psychology and/or education is preferred, but students with fewer than 20 upper-division credits in psychology, educational psychology, or special education may be admitted with limited deficiencies to be fulfilled concurrently with their graduate work. Requirements for admission include a minimum of one-third of graduate credits of A quality; satisfactory recommendations from two or more professors, preferably psychologists; and a score of 1000 or higher on the two general sections or a score of 1500 or higher, including the analytical or an advanced test, of the Graduate Record Examination. Exceptions may be made for students with special backgrounds, abilities, and interests.

Master's Degree Requirements

Students entering the program with a bachelor's degree complete the M.S. as prescribed by the Graduate School. Students qualifying for a certificate to practice in the schools must have a master's degree, about 60 graduate credits, and a practicum as described in our packet for prospective students.

Doctoral Degree Requirements

Students may be admitted with a master's degree from school psychology programs from other institutions or from related programs in this or other universities. The doctoral program includes a predissertation research requirement, which may be satisfied with a master's thesis; the core program described here (which qualifies the candidate for a school psychology certificate); a special proficiency of 12 to 18 credits; an internship; and a dissertation.

Students completing the School Psychology Core Program will have courses in the biological bases of behavior, the cognitive bases of behavior, the social bases of behavior, personality theory or abnormal psychology, human development, professional ethics and standards, research design and methodology,

SCIENCE/BUSINESS

statistics, psychometrics, counseling theory, educational foundations, educational administration, the education of exceptional children, and curriculum.

Other Relevant Information

The program has been accredited by the American Psychological Association, the National Commission for Accreditation in Teacher Education, and the Pennsylvania Department of Education.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

SCHOOL PSYCHOLOGY (S PSY)

496. INDEPENDENT STUDIES (1–18)

497, 498. SPECIAL TOPICS (1–9)

500. PROFESSIONAL ISSUES IN SCHOOL PSYCHOLOGY (1–3) Orientation to the field through study of unique problems, current issues, ethical and legal matters, unique cases, and research projects.

510. SUPERVISION OF PUPIL SERVICE PERSONNEL (1–10) Program supervision and professional leadership in university clinics and school systems. Prerequisite: S PSY 595A.

554. PSYCHOLOGICAL AND EDUCATIONAL EVALUATION OF EXCEPTIONAL CHILDREN (3) Administration and interpretation of individual tests other than the Stanford-Binet and Wechsler series. Prerequisite: S PSY (PSY) 559.

556. PSYCHOLOGICAL ASSESSMENT OF PRESCHOOL AND SCHOOL-AGED CHILDREN (2) Study of cognitive/affective tests; use of systems—analytic, multivariate statistical, actuarial methods of data combination in decision-making processes. Prerequisites: EDPSY 400, 450; EDPSY 554 or S PSY (PSY) 559.

559. (PSY 559) THE INDIVIDUAL PSYCHOLOGICAL EXAMINATION (3) Demonstrations and practice in widely used ability and aptitude tests; psychological report writing. Prerequisites: 15 credits in psychology and a course in measurement.

595A. PRACTICUM IN SCHOOL PSYCHOLOGY (1–6) Clinical experience with children under supervision in a variety of settings requiring service, including practice in synthesizing data and observations. Prerequisite: Pennsylvania Act 34 clearance required. In addition, non-Pennsylvania residents must provide evidence of an FBI background information check. Forms available: 228 Chambers Building, University Park Campus.

595B. INTERNSHIP IN SCHOOL PSYCHOLOGY (1–10) Long-term placement in settings providing work for school psychologists with children, parents, teachers, administrators, and service agencies, under supervision. Prerequisite: Pennsylvania Act 34 clearance required. In addition, non-Pennsylvania residents must provide evidence of an FBI background information check. Forms available: 228 Chambers Building, University Park Campus.

596. INDIVIDUAL STUDIES (1–9)

SCIENCE/BUSINESS, INTEGRATED FIVE-YEAR PROGRAM

Degree conferred: B.S./M.B.A. Degrees

This special program is a cooperative effort between the Eberly College of Science and The Smeal College of Business Administration. The program will provide an opportunity for students to combine and accelerate an undergraduate program in the basic sciences with a graduate program in business administration. Students admitted to this program will be able to earn a B.S. degree in General Science from the Eberly College of Science and an M.B.A. in Business Administration from The Smeal College in a total of five years. The first three years of study will include courses that satisfy the undergraduate science and General Education components of the program, and the last two years will satisfy the graduate business components of the program. With successful completion of the first three years of the program, an admission interview that confirms earlier acceptance into the program, and a satisfactory score on the Graduate Management Admission Test (GMAT), students will accelerate on to the graduate component of the program. Students earn their B.S. degree and are formally admitted to the MBA program at the end of the first semester of graduate study and earn their M.B.A. degree at the end of the second year of graduate study. In addition to the regular fall and spring semester course work, program students earn credit during

summer session through Cooperation Education and internship experiences with a number of affiliated industries and corporations.

This program seeks to combine an undergraduate program with graduate study in a professional school, and it proposes to attract and select excellent students with defined career goals. It is important to note that students in this program will have completed at least 114 undergraduate credits before entering the M.B.A. component of the program. They will satisfy all of Penn State's undergraduate General Education requirements, and they also will have as much in science course work as a four-year General Science student (General option). The main elements that are different for students in the accelerated program as compared with the regular four-year General Science major (General option) are that in the accelerated program, students will not have a foreign language requirement and students use elective credits for summer Co-op experiences and for 12 transfer credits from their first year of M.B.A. studies. Accelerated students also will have an opportunity to take special "bridge" courses and 1-credit seminar classes that will focus on traversing the boundaries among science, technology, and business.

Students will earn 12 credits of graduate work during their first semester in the two-year MBA program. These are the 12 credits that will be "double-counted" in the program. At the end of that semester, the successful student receives a B.S. degree and is admitted into the graduate program.

SOCIOLOGY (SOC)

BARRETT A. LEE, *Head of the Department*
201 Oswald Tower
814-865-0172

Degrees Conferred: Ph.D., M.A.

The Graduate Faculty

Vicki Abt, Ph.D. (Temple) *Professor of Sociology*
Roy L. Austin, Ph.D. (Washington) *Associate Professor of Sociology and Justice*
David P. Baker, Ph.D. (Johns Hopkins) *Professor of Education and Sociology*
Thomas J. Bernard, Ph.D. (SUNY Albany) *Professor of Criminal Justice and Sociology*
Alan Booth, Ph.D. (Nebraska) *Professor of Sociology and Human Development*
Richard J. Bord, Ph.D. (Iowa) *Associate Professor of Sociology*
Chester L. Britt, Ph.D. (Arizona) *Assistant Professor of Administration of Justice and Sociology*
Linda M. Burton, Ph.D. (USC) *Professor of Human Development and Sociology*
Karen P. Carver, Ph.D. (Maryland) *Assistant Professor of Sociology*
Frank Clemente, Ph.D. (Tennessee) *Professor of Sociology*
Gretchen T. Cornwell, Ph.D. (Penn State) *Assistant Professor of Rural Sociology and Sociology*
Stephen R. Couch, Ph.D. (SUNY) *Professor of Sociology*
Gordon F. De Jong, Ph.D. (Kentucky) *Distinguished Professor of Sociology*
David J. Eggebeen, Ph.D. (North Carolina) *Associate Professor of Human Development and Sociology*
Glenn Firebaugh, Ph.D. (Indiana) *Professor of Sociology*
Mark D. Hayward, Ph.D. (Indiana) *Professor of Sociology*
Craig R. Humphrey, Ph.D. (Brown) *Associate Professor of Sociology*
Rukmalie Jayakody, Ph.D. (Michigan) *Assistant Professor of Human Development and Sociology*
Leif I. Jensen, Ph.D. (Wisconsin) *Associate Professor of Rural Sociology and Sociology*
Michael P. Johnson, Ph.D. (Michigan) *Associate Professor of Sociology and Women's Studies*
Valarie King, Ph.D. (Pennsylvania) *Assistant Professor of Sociology and Human Development*
John H. Kramer, Ph.D. (Iowa) *Professor of Sociology and Justice*
Maria Krysan, Ph.D. (Michigan) *Assistant Professor of Sociology*
Nancy S. Landale, Ph.D. (Washington) *Professor of Sociology*
Barrett A. Lee, Ph.D. (Washington) *Professor of Sociology*
Daniel T. Lichter, Ph.D. (Wisconsin) *Professor of Sociology*
John D. McCarthy, Ph.D. (Oregon) *Professor of Sociology*
Diane K. McLaughlin, Ph.D. (Penn State) *Assistant Professor of Rural Sociology and Sociology*
Martina Morris, Ph.D. (Chicago) *Professor of Sociology and Statistics*
Hart M. Nelsen, Ph.D. (Vanderbilt) *Professor of Sociology*
Salvador R. Oropesa, Ph.D. (Washington) *Associate Professor of Sociology*
D. Wayne Osgood, Ph.D. (Colorado) *Professor of Crime, Law, and Justice and Sociology*

Lauri Perman, Ph.D. (Harvard) *Assistant Professor of Sociology*
 Eric Plutzer, Ph.D. (Washington—St. Louis) *Associate Professor of Political Science and Sociology*
 Suet-Ling Pong, Ph.D. (Chicago) *Associate Professor of Education and Sociology*
 Jackie Krasas Rogers, Ph.D. (Southern California) *Assistant Professor of Labor Studies and Sociology*
 R. Barry Ruback, Ph.D. (Pittsburgh) *Professor of Crime, Law, and Justice and Sociology*
 Michael J. Shanahan, Ph.D. (Minnesota) *Assistant Professor of Human Development and Sociology*
 Alan Sica, Ph.D. (Massachusetts) *Professor of Sociology*
 Graham B. Spanier, Ph.D. (Northwestern) *Professor of Human Development, Sociology, and Family and Community Medicine*
 Darrell J. Steffensmeier, Ph.D. (Iowa) *Professor of Sociology and Crime, Law, and Justice*
 C. Shannon Stokes, Ph.D. (Kentucky) *Professor of Rural Sociology and Sociology*
 Marylee C. Taylor, Ph.D. (Harvard) *Associate Professor of Sociology*
 Edward Walsh, Ph.D. (Michigan) *Associate Professor of Justice and Sociology*
 Mark Wardell, Ph.D. (Missouri) *Associate Professor of Labor Studies and Sociology*
 Rex H. Warland, Ph.D. (Iowa State) *Professor of Rural Sociology and Sociology*

The graduate program in Sociology offers advanced education for students who intend to pursue academic careers in sociology or who aspire to nonacademic research positions.

The M.A. and Ph.D. programs provide training in general social theory, research methodology, statistics, and a number of traditional and developing substantive specialties. In consultation with faculty advisers, students select two specialties that are among the department's strengths, such as classical and contemporary theory; community and environment; demography; family, life course, and aging; quantitative methods; social psychology; and stratification and social change. Alternate specialty areas not listed above may be selected as the major or the minor, with the approval of the graduate committee. Students may elect to pursue a dual-title degree in Sociology and Demography. For details, refer to the Demography program description. A separate Ph.D. program in Crime, Law, and Justice is also housed within the department. Please see the CLJ program description for details.

All students who intend to pursue doctoral work are expected to earn an M.A. degree in their normal progress to the Ph.D.

Course work outside the department is encouraged. Areas of study related to sociology, such as rural sociology, geography, economics, business administration, statistics, cultural anthropology, political science, and human development and family studies are available at the University.

Special department-related research and training facilities include on-site computer laboratories and the Population Research Institute, the Center for Research on Crime and Justice, and the Pennsylvania Commission on Sentencing. Additional University facilities used by sociology faculty and graduate students include the Computation Center (containing information about the extensive databases provided through the Inter-University Consortium for Political and Social Research) and the Gerontology Center.

Admission Requirements

Applications will be accepted through January 31 for fall admission the following year. Selection is based on undergraduate grades (and where applicable, record of previous graduate work); letters of recommendation; statement of purpose; and a sample of written work, such as a term paper; and Graduate Record Examination (GRE) verbal and quantitative scores. The best-qualified applicants will be accepted up to the number of spaces available. Students with limited prior training in sociology may be accepted, with the provision that they make up background deficiencies in the early part of their graduate program.

Degree Requirements

Required courses for the M.A. include a two-semester proseminar, one seminar each in research methods and social theory, and two seminars in social statistics. Students complete an M.A. thesis during their second year of the program.

A candidacy examination is required of all students seeking the Ph.D. This evaluation by the departmental Graduate Committee is based on the student's seminar papers, research proposal, and record of course performance and on faculty assessments of the student's ability to complete a high-quality Ph.D. program. For those admitted to the Ph.D. candidacy, a lab in teaching sociology is required, along with substantive courses in the student's major and minor areas of concentration. A comprehensive examination must be passed before the period of intensive dissertation research begins.

The Department of Sociology has no formal foreign language or communication requirement. However, students are encouraged to pursue additional training in statistics, computer science, foreign language, technical writing, specialized methods, or specialized theory that will further dissertation and career plans.

Student Aid

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AID section of the *Graduate Bulletin*, teaching assistantships support many students admitted to the program. Research assistantships also are available to qualified students through individual faculty members' grants and contracts. A number of federal agencies also offer fellowships for graduate study in sociology.

SOCIOLOGY (SOC)

400W. ADVANCED GENERAL SOCIOLOGY: THEORY, RESEARCH, AND PRACTICE (3)

401. SOCIAL INSTITUTIONS (3)

403. ADVANCED SOCIAL PSYCHOLOGY (3)

404. SOCIAL INFLUENCE AND SMALL GROUPS (3)

405. SOCIOLOGICAL THEORY (3)

406. (ADM J) SOCIOLOGY OF DEVIANCE (3)

408. URBAN ECOLOGY (3)

409. (AAA S) RACIAL AND ETHNIC INEQUALITY IN AMERICA (3)

412. (ADM J) CRIME, SOCIAL CONTROL, AND THE LEGAL SYSTEM (3)

414. (ADM J) CRIMINAL CAREERS AND THE ORGANIZATION OF CRIME (3)

416. (EDTHP) SOCIOLOGY OF EDUCATION (3)

417. (ADM J) LAW AND SOCIETY (3)

420. (EM SC, S T S) ENERGY AND MODERN SOCIETY (3)

423. SOCIAL DEMOGRAPHY (3)

424. SOCIAL CHANGE (3)

429. SOCIAL STRATIFICATION (3)

430. FAMILY IN CROSS-CULTURAL PERSPECTIVE (3)

431. (HD FS) FAMILY DISORGANIZATION: STRESS POINTS IN THE CONTEMPORARY FAMILY (3)

432. SOCIAL MOVEMENTS (3)

435. (HD FS 434) SOCIAL GERONTOLOGY (3)

436. POLLING AND PUBLIC OPINION (4)

444. COMPLEX ORGANIZATIONS (3)

446. POLITICAL SOCIOLOGY (3)

447. ENVIRONMENT, ENERGY AND SOCIETY (3)

454. THE CITY IN POSTINDUSTRIAL SOCIETY (3)

455. WORK AND OCCUPATIONS (3)

456. (WMNST) GENDER, OCCUPATIONS, AND PROFESSIONS (3)

461. (RL ST) SOCIOLOGY OF RELIGION (3)

462. (R P M) THE SOCIOLOGY OF LEISURE (3)

470. INTERMEDIATE SOCIAL STATISTICS (4)

471. QUALITATIVE RESEARCH METHODS IN SOCIOLOGY (3)

473. METHODS FOR DEMOGRAPHIC ANALYSIS (3)

496. INDEPENDENT STUDIES (1–18)

494. RESEARCH PROJECT (1–12)

497, 498. SPECIAL TOPICS (1–9)

499. FOREIGN STUDY—SOCIOLOGY (2–6)

500. INTRODUCTION TO GRADUATE STUDY IN SOCIOLOGY (1) Required of all incoming graduate students in sociology.

501. PROSEMINAR IN SOCIOLOGY (3 per semester/maximum of 6) An in-depth introduction to the major specialty areas of sociology. Prerequisite: admission to the graduate program.

502. THEORIES OF SOCIETY I (3) Review and analysis of trends and controversies in sociological theory from late eighteenth-century beginnings through the nineteenth century.

503. THEORIES OF SOCIETY II (3) Review and analysis of trends and controversies in sociological theory in the twentieth century.

504. ISSUES IN SOCIOLOGICAL THEORY (3) Seminar in the sociology of sociology, sociology of knowledge, and the philosophy of science, focusing on current theory and methodology.

512. (CLJ) SEMINAR IN DEVIANT BEHAVIOR (3) Survey of theoretical and substantive issues in deviance and criminology, with emphasis on critical review of theories.

513. SOCIOLOGICAL RESEARCH METHODS (3) Critical review of methodological issues; research designs; analysis and interpretation of findings.

514. RESEARCH DESIGN AND DATA COLLECTION METHODS (3) Chief techniques for collecting data in social research: interviews and questionnaires, laboratory and field observation, unobtrusive measures. Prerequisite: SOC 513 or equivalent course in research methods.
515. (CLJ) RESEARCH METHODS IN CRIMINOLOGY AND DEVIANCE (3) Review of methodological issues; design and conduct of research; analysis and interpretation of findings; ethical and policy issues.
520. (R SOC) APPLIED SOCIOLOGICAL AND POLICY RESEARCH (3) Survey of the conceptual and methodological issues in applied sociology and policy research conducted by sociologists. Prerequisite: SOC 574.
521. FAMILY DEMOGRAPHY (3) Current family demographic research on nuptiality, divorce, household composition, female employment, migration, and fertility.
522. DEMOGRAPHY OF THE LIFE COURSE (3) The theoretical bases, critical concepts, and methods of life course analysis in the study of demographic transitions. Prerequisites: SOC 423, 473.
523. INTERNAL AND INTERNATIONAL MIGRATION (3) Examination of theories, frameworks, and policies related to internal and international migration causes and consequences in developed and developing nations. Prerequisite: SOC 423 or prior work in population or human ecology.
531. (HD FS) FAMILY DISORGANIZATION: STRESS POINTS IN THE CONTEMPORARY FAMILY (3) Focuses on divorce, remarriage, incest, family violence as well as problems associated with family formation and parent-child relations.
535. SOCIOLOGY OF AGING (3) Current research and methodological issues in the sociological study of aging.
544. CURRENT ISSUES IN COMPLEX ORGANIZATIONS (3) Critical survey of recent developments in sociological study of organizations and the theory of bureaucracy, including reciprocal effects on environments. Prerequisite: SOC 444.
545. ECONOMY AND SOCIETY (3) Major social theorists' views on relationships of economy and society; competing sociological and economic models in contemporary social research.
546. SEMINAR IN POLITICAL SOCIOLOGY (3) Analysis of issues and problems in political sociology. Topical emphasis varies. Prerequisite: SOC 446.
547. ENVIRONMENTAL SOCIOLOGY (3) The development of environmental sociology; research issues in the study of social organization, natural resources, and social change.
551. SOCIAL STRATIFICATION AND SOCIAL CHANGE (3) Origin and development of stratification systems and inequality among and within societies; social mobility; change in stratification systems.
554. SMALL COMMUNITY POPULATION GROWTH, HUMAN ECOLOGY, AND SOCIAL CHANGE (3) Small-town population growth and ecology; images and realities of small-town life.
555. CURRENT RESEARCH IN WORK AND OCCUPATION (3) Topical seminar on nature and trends of research in the sociology of work, occupations, and professions.
574. STATISTICAL METHODS FOR SOCIAL RESEARCH (3) Basic concepts of statistics; linear regression; computer software; analysis of social surveys; causal inferences from nonexperimental data. Prerequisites: 3 credits of statistics, 3 credits of research methods.
575. STATISTICAL MODELS FOR NONEXPERIMENTAL RESEARCH (3) Causal models for quantitative and qualitative data; path analysis and structural equations; logistic regression; duration models. Prerequisite: SOC 574.
576. APPLIED MATHEMATICAL DEMOGRAPHY (3) Survey of mathematical models used in the study of population: models of growth, survivorship, fertility, migration, stability, kinship, projection. Prerequisites: SOC 473 or ANTH 408; calculus.
577. TECHNIQUES OF EVEN HISTORY MODELING (3) Survival analysis theory and methods for discrete dependent variables. Prerequisite: SOC 575.
583. RESEARCH SEMINAR IN SOCIAL PSYCHOLOGY (3) Design and conduct of research in areas of contemporary social psychology.
584. (PSY) ATTITUDE FORMATION AND CHANGE (3) Theory and method in research on attitude formation and change with emphasis on critical analysis. Prerequisites: SOC 403 or PSY 417; 3 credits in statistics.
585. (PSY) INTERACTION PROCESSES WITHIN AND BETWEEN GROUPS (3) Interactions in personal, group, and intergroup relations; theory and observational methods. Prerequisite: SOC 403 or PSY 417.
586. (PSY) THE SOCIAL PSYCHOLOGY OF SOCIAL CHANGE (3) The interaction of individual, social, and cultural determinants of group and individual change; emphasis on social movements, crowds, and audiences. Prerequisite: SOC 403 or PSY 417.
587. (PSY) SOCIALIZATION (3) Behavioral, cognitive, developmental, symbolic, interactionist, and role theories of socialization; emphasis on current theory and research. Prerequisite: SOC 403 or PSY 417.

588. (PSY) THE SOCIAL ORGANIZATION OF ATTRIBUTION (3) Principles of attribution and their relevance to such topics as power relations, authority, equity, injustice, and social movements. Prerequisite: SOC 403 or PSY 417.
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

SOIL SCIENCE (SOILS)

S. L. FALES, *Head, Department of Agronomy*
116 Agricultural Sciences and Industries Building
814-865-6541

G. W. PETERSEN, *Chair of the Graduate Program in Soil Science*
444 Agricultural Sciences & Industries Building
814-865-1540

Degrees Conferred: Ph.D., M.S., M.Agr.

The Graduate Faculty

Dale E. Baker, Ph.D. (Missouri) *Professor Emeritus of Soil Chemistry*
Douglas B. Beegle, Ph.D. (Penn State) *Professor of Agronomy*
Jean-Marc Bollag, Ph.D. (Basel) *Professor of Soil Microbiology*
Jon D. Chorover, Ph.D. (California) *Assistant Professor of Environmental Soil Chemistry*
Edward J. Ciolkosz, Ph.D. (Wisconsin) *Professor of Soil Genesis and Morphology*
Robert L. Cunningham, Ph.D. (Washington State) *Professor Emeritus of Soil Genesis and Morphology*
Rick L. Day, Ph.D. (Penn State) *Assistant Professor of Science and Environmental Information Systems*
Richard H. Fox, Ph.D. (Arizona) *Professor of Soil Science*
Daniel D. Fritton, Ph.D. (Iowa State) *Professor of Soil Physics*
Jon K. Hall, Ph.D. (Penn State) *Associate Professor of Soil Chemistry*
Leon J. Johnson, Ph.D. (Penn State) *Professor Emeritus of Soil Mineralogy*
Sridhar Komarneni, Ph.D. (Wisconsin) *Professor of Clay Mineralogy*
Peter J. Landschoot, Ph.D. (Rhode Island) *Associate Professor of Turfgrass Science*
Les E. Lanyon, Ph.D. (Ohio State) *Associate Professor of Soil Fertility*
Charles F. Mancino, Ph.D. (Massachusetts) *Associate Professor of Turf/Soil Science*
Egide Nizeyimana, Ph.D. (Illinois) *Senior Research Associate*
Gary W. Petersen, Ph.D. (Wisconsin) *Professor of Soil and Land Resources*
Harry B. Pionke, Ph.D. (Wisconsin) *Adjunct Professor of Soil Science*
Andrew S. Rogowski, Ph.D. (Iowa State) *Adjunct Professor of Soil Physics*
Gregory W. Roth, Ph.D. (Penn State) *Associate Professor of Corn Management*
Ronald R. Schnabel, Ph.D. (Washington State) *Adjunct Assistant Professor of Soil Science*
Andrew N. Sharpley, Ph.D. (Massey, New Zealand) *Adjunct Professor of Soil Science*
Richard C. Stehouwer, Ph.D. (Ohio State) *Assistant Professor of Environmental Soil Science*
William L. Stout, Ph.D. (Penn State) *Adjunct Assistant Professor of Soil Science*
A. J. Turgeon, Ph.D. (Michigan State) *Professor of Agronomy*
Donald V. Waddington, Ph.D. (Massachusetts) *Professor Emeritus of Soil Science*
Ann M. Wolf, Ph.D. (Penn State) *Affiliate Assistant Professor of Soil Science*

The Soil Science program is administered in the Department of Agronomy, College of Agricultural Sciences. Each student will be associated with an adviser who may provide financial support, research facilities, and/or office space. Applicants are encouraged to explore, study, and research opportunities by contacting faculty who may be prospective advisers.

This program provides opportunities for candidates interested in soil and related water resources to become a professional leader and an independent scholar. Faculty in this program are competent to prepare candidates in the subfields of Soil Science including soil genesis, soil classification, soil morphology, soil mapping, soil physics, soil chemistry, soil mineralogy, soil fertility, soil conservation, land waste disposal, geographic information systems, soil environmental chemistry, computer mapping, watershed analysis, soil hydrology, soil and water management, resource inventory and assessment, environmental soils, remote sensing, land evaluation, and land management.

Admission Requirements

Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination, are required for admission. At the discretion of the graduate standards committee, a student may be admitted provisionally for graduate study in the program without these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Prerequisites for major work in Soil Science vary with the area of specialization and the degree sought, but courses in chemistry, mathematics, physics, geology, basic and applied biological sciences, and English communication skills are required. Applicants for the M.S. degree should have a baccalaureate degree including 76 credits of basic and applied natural sciences. For the M.Agr. degree program, an applicant must present a baccalaureate degree in agricultural or forest science. A minimum junior/senior grade-point average of 3.2 (on a 4.00 scale) is required. Exceptions to these requirements may be made for students with special backgrounds, abilities, and interests. Admission to the Ph.D. program requires an M.S. or equivalent degree with a minimum cumulative grade-point average of 3.25 (on a 4.00 scale). Applicants for the Ph.D. program will be evaluated on the quality of work completed in all previous degree programs. Students who lack some of the prerequisite courses may be admitted but are required to take these courses without degree credit. The best-qualified applicants will be accepted up to the number of spaces available for new students.

Master's Degree Requirements

In addition to the general requirements for the M.S. degree as defined by the Graduate School, the department requires 12 credits of 400- or 500-level formal courses in the major field of which 6 must be 500-level. Participation in at least one colloquium course each semester is required and students must complete at least 1 credit of colloquium (SOILS 590). An advisory committee will be appointed for each student and additional courses and requirements may be determined by this advisory committee.

A thesis based on field and/or laboratory research is required for the M.S. degree. Candidates for the M.Agr. degree may prepare a paper based on library research in lieu of a thesis. Both M.S. and M.Agr. candidates must pass a final examination.

Doctoral Degree Requirements

Beyond the general requirements for the Ph.D. defined by the Graduate School, the department has a number of specific requirements regarding course level and distribution that are defined in the departmental publication "Graduate Degrees in Soil Science." While a minimum number of courses for the degree is not specified, the doctoral advisory committee has the responsibility of specifying courses and credits essential for the education and development of the candidate. Students are expected to be educated in depth in a specific subfield of Soil Science and to have a perspective of the general field. Normally, 55 to 60 credits in formal course work beyond the B.S. degree are required. Doctoral candidates are required to participate regularly in a departmental colloquium and to register for at least 2 credits of colloquium (SOILS 590) during the Ph.D. program.

The communication and foreign language requirement for the Ph.D. degree may be met either by demonstrating a knowledge of at least one foreign language or by completing at least 6 credits of course work in an area of English communications approved by the student's advisory committee.

In addition to the candidacy, comprehensive, and final oral examinations, the department requires a competency evaluation to be taken after a student passes the candidacy. The purpose of this evaluation is to determine the student's strengths and weaknesses in pertinent subject matter and to assist the advisory committee in providing direction relative to required course work.

Other Relevant Information

Every student has a close professional relationship with his or her faculty adviser. While research that is done for the thesis will be on subjects that fall within the ongoing research program of the adviser, students are encouraged to propose research projects that are of interest to them. For the most part, all costs relative to the research program will be covered by the department. The department encourages professional development of students through participation in meetings of relevant professional societies and organizations.

Student Aid

Graduate assistantships and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

SOIL SCIENCE (SOILS)

- 401. SOIL COMPOSITION AND PHYSICAL PROPERTIES (3)
- 402. CHEMISTRY OF SOILS AND FERTILIZERS (3)
- 403. (AGRO) PROPERTIES AND MANAGEMENT OF TROPICAL SOILS (2)
- 415. SOIL MORPHOLOGY, MAPPING, AND LAND USE (3)
- 416. SOIL GENESIS AND CLASSIFICATION (3)
- 419. (GEOG 418) SOIL ENVIRONMENTAL CHEMISTRY (4)
- 422. CONSERVATION OF SOIL AND WATER RESOURCES (3)
- 489. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1–3)
- 490. (AGRO) SOILS COLLOQUIUM (1)
- 495. INTERNSHIP (1–5)
- 496. INDEPENDENT STUDIES (1–8)
- 497. SPECIAL TOPICS (1–9)

501. SOIL FERTILITY (3) Soil–plant relations emphasizing recent concepts of ion accumulation by plants as affected by soil conditions and plant physiology. Prerequisites: SOILS 402, BIOL 441.

506. (GEOSC 513) SOIL PHYSICAL CHEMISTRY (3) Surface and colloid chemistry of soils including sorption processes and kinetics, dissolution reactions, particle interactions, and associate modeling techniques. Prerequisites: SOILS 419, CHEM 451.

507. SOIL PHYSICS (3–4) Soil physical properties emphasizing water, heat, gas, and ion movement in unsaturated soils. Laboratory included with 4 credits. Prerequisites: 6 credits each of calculus, physics, and soils.

510. GEOGRAPHIC INFORMATION SYSTEM APPLICATIONS (3) Introduction to digitized soil data bases and several geographic information system software packages. Data capture, modelling, and image development and interpretation of digitized soil and related data are applied to understanding land and water resources, their management, and use-limitations. Prerequisites: SOILS 415, 416, GEOG 457.

516. SOIL GENESIS (1 per semester, maximum of 4) Field trip to study the genesis, classification, and geomorphology of the major soils of the northeastern United States. Prerequisite: SOILS 416 or 6 credits in geology or physical geography.

519. NATURE OF SOIL MINERALS (3) Constituent minerals of soils: modern methods for identification; relations to soil formation and agricultural practices. Prerequisite: SOILS 401.

590. (AGRO) SOILS COLLOQUIUM (1–3)

596. INDIVIDUAL STUDIES (1–9)

597. SPECIAL TOPICS (1–9)

See also Agronomy.

SPANISH (SPAN)

TERRY J. PEAVLER, *Interim Head of the Department of Spanish, Italian, and Portuguese*
N352 Burrowes Building
814-865-4252

Degrees Conferred: Ph.D., M.A., M.Ed.

The Graduate Faculty

Mary E. Barnard, Ph.D. (Michigan) *Associate Professor of Spanish and Comparative Literature*

Aida M. Beaupied, Ph.D. (Yale) *Assistant Professor of Spanish*

Rosalía Cornejo, Ph.D. (Penn State) *Assistant Professor of Spanish*

Frederick A. de Armas, Ph.D. (North Carolina) *Distinguished Professor of Spanish and Comparative Literature*

Javier Escudero, Ph.D. (Virginia) *Associate Professor of Spanish*

Anibal Gonzalez-Perez, Ph.D. (Yale) *Edwin Erle Sparks Professor of Spanish*

John R. Gutierrez, Ph.D. (New Mexico) *Associate Professor of Spanish*

Julia Cuervo Hewitt, Ph.D. (Vanderbilt) *Associate Professor of Spanish and Portuguese*

Robert F. Lima, Jr., Ph.D. (NYU) *Professor of Spanish and Comparative Literature*

Leon F. Lyday, Ph.D. (North Carolina) *Professor of Spanish*

Guadalupe Martí-Peña, Ph.D. (Washington) *Lecturer in Spanish*

Priscilla Melendez, Ph.D. (Cornell) *Associate Professor of Spanish*

Terry J. Peavler, Ph.D. (California) *Professor of Spanish*

SPANISH

Ana Teresa Perez-Leroux, Ph.D. (Massachusetts) *Assistant Professor of Spanish and Linguistics*

Laurence E. Prescott, Ph.D. (Indiana) *Associate Professor of Spanish and African/African American Studies*

Beno Weiss, Ph.D. (NYU) *Professor of Italian*

The program offers M.A. options in literature and linguistics, as well as doctoral emphasis in either of these two areas.

Admission Requirements

Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

The minimum requirement for admission normally will be 24 credits of postintermediate work in Spanish language and literature.

Students with a 3.00 junior/senior average (on a 4.00 scale) and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

Degree Requirements

A candidate for the M.A. degree must take a minimum of 30 credits at the graduate level including 6 credits in a related minor field. An M.A. essay and a comprehensive written examination also are required. The M.A. degree (or equivalent) is normally a prerequisite to doctoral candidacy.

Candidates for the M.Ed. degree must take 6 credits in a field of professional education.

For the Ph.D. degree, a student must complete at least 60 credits (including M.A. credits) of graduate-level work, including a 15-credit minor. Other requirements include (1) a doctoral candidacy examination and written area examinations; (2) reading knowledge of two foreign languages or a comprehensive knowledge of one foreign language; and (3) a doctoral dissertation.

Student Aid

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AID section of the *Graduate Bulletin*, the following awards typically have been available to graduate students in this program:

EDWIN ERLE SPARKS DISSERTATION FELLOWSHIP IN THE HUMANITIES—Available to a doctoral candidate in one of the following graduate programs: Comparative Literature, English, French, German, History, Linguistics, Philosophy, Spanish, and Speech Communication; stipend \$9,700 plus waiver of tuition. Apply to department before February 1.

EDWIN ERLE SPARKS FELLOWSHIPS IN THE HUMANITIES (8)—Available to beginning and continuing graduate students in one of the following graduate programs: Comparative Literature, English, French, German, History, Linguistics, Philosophy, Spanish, and Speech Communication; stipend \$9,060 plus waiver of tuition. Apply to department before February 1.

SPANISH (SPAN)

400. ADVANCED STYLISTICS (3)

410. ADVANCED ORAL EXPRESSION AND COMMUNICATION (3)

412. TRANSLATION (3)

414. SPANISH PHONOLOGY (3)

415. SPANISH MORPHOLOGY AND SYNTAX (3)

418. THE EVOLUTION OF SPANISH (3)

420. TEACHING OF ROMANCE LANGUAGES (3)

439. DON QUIJOTE (3)

440. (IT) TEACHING OF ROMANCE LANGUAGES (3)

472. THE CONTEMPORARY SPANISH AMERICAN NOVEL (3)

476. MASTERPIECES OF SPANISH AMERICAN LITERATURE (3)

490. MASTERPIECES OF SPANISH PROSE (3)

491. MASTERPIECES OF SPANISH DRAMA AND POETRY (3)

494. RESEARCH PROJECT (1-12)

496. INDEPENDENT STUDIES (1–18)

497. SPECIAL TOPICS (1–9)

499. FOREIGN STUDY—SPANISH (3)

001G. ELEMENTARY SPANISH FOR GRADUATE STUDENTS (3) Instruction in fundamental skills required for reading expository Spanish prose; primarily for advanced degree language requirements. Prerequisite: graduate standing.

002G. ELEMENTARY SPANISH FOR GRADUATE STUDENTS (3) Continuation of SPAN 001G, with opportunity for reading in special fields. Prerequisites: SPAN 001G, graduate standing.

502. THEORY AND TECHNIQUES OF TEACHING SPANISH (1–3) Communicative orientation.

507. HISPANO-ROMANCE LINGUISTICS (3 per semester, maximum of 9) History, development, and linguistic description of Old Spanish and related Romance languages of the Iberian Peninsula.

510. SPANISH DESCRIPTIVE LINGUISTICS: PHONOLOGY (3)

511. SPANISH TRANSFORMATIONAL-GENERATIVE LINGUISTICS (3)

514. HISPANIC DIALECTOLOGY (3 per semester, maximum of 6) Early fragmentation among the peninsular dialects; their status today, Judeo-Spanish; descriptive analysis of modern Spanish American dialects.

516. MEDIEVAL SPANISH LITERATURE (3 per semester, maximum of 9) Topics vary; *juglaría* and *clerecía*, emergence of lyric and brief narrative; history and didacticism; origins of novel; balladry; fifteenth-century innovations.

521. THE *CELESTINA* AND THE LITERATURE OF THE SPANISH PRE-RENAISSANCE (3) Chief trends and works of the period of the Catholic monarchs, with special emphasis on Fernando de Rojas's masterpiece *La Celestina*.

526. SIXTEENTH-CENTURY SPANISH LITERATURE (3 per semester, maximum of 9) Prose and poetry of major authors: works and trends of the Renaissance and the early Golden Age.

528. SEVENTEENTH-CENTURY SPANISH LITERATURE (3 per semester, maximum of 9) Prose and poetry of major authors: works and trends of the late Golden Age and Baroque period.

537. GOLDEN AGE THEATRE (3 per semester, maximum of 6) Major works of Lope de Vega, Tirso de Molina, Calderón, and others.

540. CERVANTES (3 per semester, maximum of 9) The literary works of Cervantes: *Don Quijote*, other novels, dramatic works, and poetry.

544. SPANISH ROMANTICISM (3) The major authors and works of peninsular romanticism, including poetry, drama, and prose.

550. SPANISH REALISM (3) The major figures of the period with special emphasis on Pérez Galdós.

553. WRITINGS OF THE "GENERATION OF 1898" (3 per semester, maximum of 6) Novels, plays, short stories, essays, poetry of Valle-Inclán, Azorín, Benavente, Unamuno, Machado, Maeztu, and Baroja in the context of generation concept.

560. THE CONTEMPORARY NOVEL IN SPAIN (3) The novel since 1941: Cela, Laforet, Zuzunegui, Suárez Carreño, Matute, and others.

563. CONTEMPORARY DRAMA IN SPAIN (3) Contemporary drama: Garcia Lorca, Casona, Buero Vallejo, Sastre, Olmo, Muniz, Recuerda, Rodríguez Mendez, Nieva, Riaza, Arrabal, Pedrera, and others.

566. CONTEMPORARY SPANISH POETRY (3) Various currents in Spanish poetry from the generation of 1927: Lorca, Aleixandre, Salinas, Guillén, Alonso, Alberti, Hernández, Otero, and others.

568. EARLY SPANISH AMERICAN LITERATURE (3 per semester, maximum of 9) Content varies; selected topics from colonial period, romanticism, and the nineteenth century before modernism.

570. MODERNISMO (3) The movement, its antecedents, and its followers, with special emphasis on Rubén Darío.

574. THE SPANISH AMERICAN NOVEL (3 per semester, maximum of 9) Content varies; selected works from the late nineteenth century through the contemporary period.

575. THE SPANISH AMERICAN ESSAY (3) Tracing the history of ideas in Spanish America through major essayists.

576. TWENTIETH-CENTURY SPANISH AMERICAN POETRY (3) Influential poets and literary movements after *modernismo*.

577. SPANISH AMERICAN DRAMA (3) Dramatic literature in Spanish America from colonial times to the present.

581. THE SPANISH AMERICAN SHORT STORY (3) Critical analysis of the major writers and movements from Echevarría to the present.

587. STYLISTIC AND LITERARY CRITICISM (3) Major theories of literary criticism applied to Hispanic literature.

SPECIAL EDUCATION

588. SEMINAR IN HISPANIC LITERATURE (3-12) Common and individual research in special problems in Spanish or Spanish American literature.

589. (CMLIT, FR, GER) TECHNOLOGY IN FOREIGN LANGUAGE EDUCATION: AN OVERVIEW (3) Approaches to the uses and research applications of multimedia and other educational technologies applied to the teaching of foreign language.

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

SPECIAL EDUCATION (SPLED)

ROBERT L. HALE, *Head of the Department of Educational and School Psychology and Special Education*
227 CEDAR Building
814-865-6072

JAMES K. McAFEE, *In Charge of Graduate Programs in Special Education*
211 CEDAR Building
814-863-8115

Degrees Conferred: Ph.D., M.S., M.Ed.

The Graduate Faculty

Joseph L. French, Ed.D. (Nebraska) *Professor Emeritus of Education*
Anna H. Gajar, Ph.D. (Virginia) *Professor of Special Education*
Tracey E. Hall, Ph.D. (Oregon) *Assistant Professor of Education*
Charles A. Hughes, Ph.D. (Florida) *Professor of Special Education*
Robert C. MacMillan, Ed.D. (Alabama) *Assistant Professor of Special Education*
James K. McAfee, Ph.D. (Georgia State) *Associate Professor of Special Education*
David B. McNaughton, Ph.D. (Penn State) *Assistant Professor of Education*
John T. Neisworth, Ph.D. (Pittsburgh) *Professor of Special Education*
Kathy L. Ruhl, Ph.D. (Florida) *Associate Professor of Special Education*
John Salvia, D.Ed. (Penn State) *Professor of Special Education*
Pamela S. Wolfe, Ph.D. (Virginia) *Assistant Professor of Special Education*

Exceptional children are those who deviate so far from average in physical, intellectual, emotional, or social characteristics that they do not profit adequately from the usual public school program. The purpose of the M.Ed. program in Special Education is to prepare teachers of exceptional children. M.Ed. students are trained in behavior management and instructional design, implementation, and evaluation appropriate for effective work with children and youth who qualify for services for mental retardation, emotional disturbance, and learning disabilities at all age levels and degrees of severity. The purpose of the M.S. and Ph.D. programs is to prepare researchers and college and university teachers in areas encompassing the education of the children and youth who qualify for services for mental retardation, emotional disturbance and learning disabilities. The former program is professional in nature; the latter two, academic.

Admission Requirements

Scores from the Graduate Record Examination (GRE) or from the Miller Analogies Test (MAT) are required for admission. At the discretion of a graduate program, a student may be admitted provisionally for graduate study in a program without these scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Highest admission priorities are given to applicants who possess certification in special education or elementary education. Applicants for master's and doctoral programs must present evidence of superior academic achievement, complete a personal statement, present GRE verbal and quantitative test scores, or MAT scores (master's only), and provide professional references. Minimum GRE test scores of master's and doctoral applicants, respectively, are GRE (verbal and quantitative combined), 900 and 1100 (3). Applicants for doctoral study must have had at least three years of relevant experience with special-needs children. Applicants from foreign countries whose first language is not English must submit TOEFL (Test of English as a Foreign Language) scores. Exceptions to the admissions criteria may be made only for highly qualified students with special backgrounds, abilities, and interests.

Master's Degree Requirements

Prerequisites for the M.Ed. program include 26 credits basic to the education of exceptional children (courses comparable to SPLED 305, 401, 454, and 495E; LL ED 400, MTHED 420; a 400-level course in child development or child psychology; and a 400-level course in foundations of education). Of the 30 credits required for the M.Ed. degree, 6 must be taken from fields outside of special education; at least 18 must be taken in special education; and 15 credits must be taken at the 500 level. SPLED 573 is required along with two practica: SPLED 595A and 595B. M.Ed. students must submit a master's paper.

Of the 30 credits required for the M.S. degree, 6 must be taken from one discipline outside of education; 18 must be taken in special education; and 18 must be taken at the 500 level or above. SPLED 573 and EDPSY 400 are required as are 6 credits of thesis research, SPLED 600. M.S. students must submit a master's thesis and pass a comprehensive examination.

All requirements for either the M.Ed. or the M.S. degree, whether satisfied on the University Park Campus or elsewhere, must be met within six years or a period spanning seven consecutive summers.

Doctoral Degree Requirements

The communication and foreign language requirement for the Ph.D. degree is prescribed by each student's committee. The requirements include the successful completion of a philosophy of science course (e.g., PHIL 421) and additional language and communication abilities such as foreign language competence, computer programming skills, expertise with alternative communication systems, research publication, etc. Minimum requirements for the Ph.D. degree include 24 credits of research methods; 18 credits in a cognate area such as psychology, sociology, or child development; and 36 credits in education. The student also must enroll in SPLED 500 each semester prior to successful completion of the comprehensive examinations. A candidacy examination is required no later than the second semester of full-time study; written and oral comprehensive examinations are required following the satisfactory completion of the language requirement. A student is required to complete the program within seven years from the date of acceptance as a candidate.

Student Aid

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AID section of the *Graduate Bulletin*, the following award typically has been available to graduate students in this program:

U.S. OFFICE OF EDUCATION ASSISTANTSHIPS OR TRAINEESHIPS IN SPECIAL EDUCATION—Open to graduate students being prepared as leadership personnel in special education; stipend varies, depending on conditions of existing grants. Other graduate assistantships also may be available. Apply to the Graduate Admissions Committee, 227 CEDAR Building.

SPECIAL EDUCATION (SPLED)

- 400. TEACHING EXCEPTIONAL STUDENTS IN GENERAL EDUCATION SETTINGS (3)
- 401. MOTIVATING EXCEPTIONAL LEARNERS (4)
- 402. HUMAN RIGHTS: HISTORICAL AND CURRENT ISSUES IN SPECIAL EDUCATION (3)
- 404. WORKING WITH FAMILIES AND PROFESSIONALS IN SPECIAL EDUCATION (3)
- 409. CURRICULUM FOR STUDENTS WITH SPECIAL NEEDS (6)
- 411. INTERVENTION FOR STUDENTS WITH SEVERE DISABILITIES (3)
- 412. INSTRUCTION FOR STUDENTS WITH MILD DISABILITIES (4)
- 415. EARLY SPECIAL EDUCATION (3–4)
- 418. TECHNOLOGIES FOR PERSONS WITH DISABILITIES (2)
- 444. INCLUSIVE EDUCATION AND ASSESSMENT (6)
- 454. ASSESSMENT FOR INSTRUCTION (4)
- 495E. EXPERIENCE WITH EXCEPTIONAL CHILDREN (3)
- 495F. PRACTICUM IN SPECIAL EDUCATION (15)
- 495G. EXPERIENCE WITH AN INTEGRATED INCLUSION CLASSROOM (3)
- 496. INDEPENDENT STUDIES (1–18)
- 497. SPECIAL TOPICS (1–9)
- 498. SPECIAL TOPICS (1–9)

500. SEMINAR IN SPECIAL EDUCATION (1–9) Continuing series of professional seminars designed to provide a forum for discussion of current and classical research concerning exceptional children. Prerequisites: EDPSY 400; 6 credits in special education.

SPEECH COMMUNICATION

501. ADMINISTRATION AND SUPERVISION OF EDUCATIONAL PROGRAMS FOR EXCEPTIONAL CHILDREN (2-3) Problems connected with the instituting and organizing of classes for atypical children; the legal phases, finances, teaching personnel, pupil personnel, housing, equipment, courses of study, curriculum, etc. Prerequisites: SPLED 401 and EDADM 480 or teaching, administrative, or supervisory experience.

510. PROBLEMS IN THE EDUCATION OF THE MENTALLY RETARDED (2-4) Study of existing curricula, instructional practices, educational programs; experimentation in curriculum building and materials construction. Prerequisites: SPLED 305; SPLED 401 or 411.

515. INFANTS AND TODDLERS WITH SPECIAL NEEDS (3) Comparison of typical and atypical development of infants and toddlers; applicable instructional strategies in education. Prerequisite: at least one year teaching experience with elementary-age children.

516. ASSESSMENT IN EARLY EDUCATIONAL INTERVENTION (2-3) Describes and illustrates models, methods, and materials for assessing infants and preschoolers with developmental delays and disabilities. Prerequisite: SPLED 415.

530. PROBLEMS IN THE EDUCATION OF THE LEARNING DISABLED (2-4) Review of the research and theoretical implications in the educational and behavioral management of learning disabled children. Prerequisite: SPLED 305.

550. PROFESSIONAL SEMINAR IN SPECIAL EDUCATION (1) Professional competencies and ethical issues related to obtaining and retaining positions in higher education. Prerequisite: Successful completion of candidacy in Special Education.

555. CURRICULUM-BASED ASSESSMENT FOR HANDICAPPED LEARNERS (2) Development and use of diagnostic procedures for planning and evaluating instructional programs for handicapped pupils. Prerequisites: SPLED 454; SPLED 305 or 400.

570. PROBLEMS IN THE EDUCATION OF THE EMOTIONALLY DISTURBED (2-4) Current issues, methods, and problems associated with the education of the emotionally/behaviorally disturbed. Concurrent: SPLED 305, 401.

573. PROBLEMS OF RESEARCH WITH HANDICAPPED GROUPS (2) A seminar to review and design research studies for the education and training of handicapped groups. Prerequisite or concurrent: SPLED 454.

575. GRANT-PROPOSAL DEVELOPMENT IN SPECIAL EDUCATION (3) Designed to facilitate development of grants and proposal writing techniques for submission and funding by student researchers. Prerequisites: SPLED 573, EDPSY 400.

594. RESEARCH TOPICS (1-15)

595A. PRACTICUM (1-6) Supervised clinical experience on campus in University-managed diagnostic and remedial settings. Prerequisites: SPLED 412. Pennsylvania Act 34 clearance required. In addition, non-Pennsylvania residents must provide evidence of an FBI background information check. (Forms available: 228 Chambers Building, University Park Campus.)

595B. FIELD EXPERIENCES IN OFF-CAMPUS LABORATORIES (1-10) Supervised off-campus field experiences in selected laboratory settings with exceptional children. Prerequisites: SPLED 412.

595A. Pennsylvania Act 34 clearance required. In addition, non-Pennsylvania residents must provide evidence of an FBI background information check. (Forms available: 228 Chambers Building, University Park Campus.)

595C. INTERNSHIP IN SPECIAL EDUCATION SUPERVISION (1-6) Internship in day/residential school setting under supervision of field supervisor and University faculty. Prerequisite: SPLED 595B.

595D. INTERNSHIP IN SPECIAL EDUCATION (2-10) Internship to take place in schools or educational situations where student is not regularly employed, under supervision of graduate faculty. Prerequisite: SPLED 495F or teaching experience.

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

SPEECH COMMUNICATION (SPCOM)

MICHAEL L. HECHT, *Head of the Department*
234 Sparks Building
814-865-3461

Degrees Conferred: Ph.D., M.A.

The Graduate Faculty

Deborah F. Atwater, Ph.D. (SUNY, Buffalo) *Associate Professor of Speech Communication and African and African American Studies*
 Thomas W. Benson, Ph.D. (Cornell) *Edwin Erle Sparks Professor of Rhetoric*
 Stephen H. Browne, Ph.D. (Wisconsin) *Associate Professor of Speech Communication*
 J. Louis Campbell III, Ph.D. (Minnesota) *Associate Professor of Speech Communication*
 Daniel J. Canary, Ph.D. (USC, Los Angeles) *Professor of Speech Communication*
 Dennis S. Gouran, Ph.D. (Iowa) *Professor of Speech Communication*
 Richard B. Gregg, Ph.D. (Pittsburgh) *Professor of Speech Communication*
 Michael L. Hecht, Ph.D. (Illinois) *Professor of Speech Communication*
 Grant H. Henning, Ph.D. (UCLA) *Professor of Speech Communication*
 Michael J. Hogan, Ph.D. (Wisconsin—Madison) *Professor of Speech Communication*
 Karen E. Johnson, Ph.D. (Syracuse) *Associate Professor of Speech Communication*
 Christopher L. Johnstone, Ph.D. (Wisconsin) *Associate Professor of Speech Communication*
 Tony M. Lentz, Ph.D. (Michigan) *Assistant Professor of Speech Communication*
 Wayne J. McMullen, Ph.D. (Penn State) *Assistant Professor of Speech Communication*
 Mary K. Mino, Ph.D. (Penn State) *Associate Professor of Speech Communication*
 Sandra J. Savignon, Ph.D. (Illinois, Urbana-Champaign) *Professor of Speech Communication*
 Judith L. Stephens, Ph.D. (Kent State) *Associate Professor of Speech Communication*
 Jane Sutton, Ph.D. (Colorado) *Associate Professor of Speech Communication*
 Barbara W. Uncapher, Ph.D. (Pittsburgh) *Assistant Professor of Speech Communication*
 Arden K. Watson, Ed.D. (Vanderbilt) *Associate Professor of Speech Communication*
 Molly Wertheimer, Ph.D. (Penn State) *Associate Professor of Speech Communication*
 Nancy J. Wyatt, Ph.D. (Penn State) *Associate Professor of Speech Communication*

Students may specialize in communication theory, English as a second language, or rhetoric.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are required for admission. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

The minimum undergraduate preparation is 12 credits in speech. Students who cannot meet this requirement in full may be admitted but must make up their deficiencies without credit toward the graduate degree.

Additionally, students with a 3.00 junior/senior grade-point average (on a 4.00 scale) and appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests. A student must have completed the master's degree before being admitted as a doctoral candidate.

Master's Degree Requirements

Students pursuing the M.A. degree in Speech Communication must take one of two options: (1) a thesis track, or (2) a nonthesis track. In either track, SPCOM 420 or 440W is required for those who do not have the equivalent. In either track, candidates must schedule a review of their program of courses during the first year of residence and receive approval by a duly constituted advisory committee.

For those taking the thesis option, a total of 30 credits, including 6 for the thesis and at least 12 other 500-level credits, is required. Candidates in this track must schedule a proposal meeting in which their research plan for their thesis is approved by their committee. They are also required to present an oral defense before their committee.

Students taking the second option must complete 36 credits of course work, of which 18 credits must be at the 500 level, a comprehensive examination, and a master's paper that entails original research. The candidate's advisory committee will determine whether the requirements for the comprehensive examination and M.A. paper have been successfully completed. These determinations ordinarily will not require an oral examination.

Doctoral Degree Requirements

The communication and foreign language requirement for the Ph.D. degree may be satisfied by options selected from designated areas including, but not restricted to, foreign languages. SPCOM 420 or 440 is required of all graduate students who do not have their equivalent. Doctoral candidates must schedule a

candidacy evaluation during their first year. Following completion of the language requirement, doctoral candidates must take a comprehensive examination to determine their mastery and competence in speech communication. Doctoral candidates must schedule a proposal meeting at which the research plan for their dissertation is approved by their committee. Doctoral candidates must present a final oral defense of their dissertation before their committee.

Student Aid

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AID section of the Graduate Bulletin, the following awards typically have been available to graduate students in this program:

EDWIN ERLE SPARKS FELLOWSHIPS IN THE HUMANITIES (8)—Available to beginning and continuing graduate students in one of the following graduate programs: Comparative Literature, English, French, German, History, Linguistics, Philosophy, Spanish, and Speech Communication; stipend \$12,260 plus waiver of tuition. Apply to department before February 1.

SPEECH COMMUNICATION (SPCOM)

*114G. BASIC ENGLISH AS A SECOND LANGUAGE (3) Instruction in English as a second language for international students that focuses on basic aspects of English reading, writing, listening, and speaking skills.

*115G. ENGLISH AS A SECOND LANGUAGE: SPEAKING AND LISTENING (3–9) English as a second language focusing on speaking and listening skills.

*116G. ENGLISH AS A SECOND LANGUAGE: READING AND WRITING (3–9) English as a second language for graduate students; focusing on reading and writing skills.

*117G. ENGLISH AS A SECOND LANGUAGE FOR TEACHING ASSISTANTS I (3–9) English as a second language for preparation of international teaching assistants. Prerequisites: SPCOM 115G, with a grade of A or TSE score of 200.

*118G. ENGLISH AS A SECOND LANGUAGE FOR TEACHING ASSISTANTS II (3) Advanced course in English as a second language for preparation of international teaching assistants. Prerequisite: SPCOM 117G or TSE score of 229+.

400. SPEECH COMMUNICATION TRAINING IN BUSINESS (3)

401. SPEECH COMMUNICATION RESEARCH METHODS (3)

402. SPEECH AND HUMAN BEHAVIOR (3)

403. INTERPERSONAL ORAL COMMUNICATION THEORY (3)

404. COMMUNICATION IN CONFLICT RESOLUTION AND NEGOTIATION (3)

410. AMERICAN-ENGLISH PHONETICS (3)

412. SPEECH CRITICISM (3)

413. EXPERIMENTAL LINGUISTICS (3)

414. SPEECH SCIENCE (3)

415. RHETORIC OF FILM AND TELEVISION (3)

420. SYSTEMS AND THEORIES OF RHETORIC (3)

422. (AAA S) CONTEMPORARY BLACK RHETORIC (3)

426W. COMMUNICATION AND RESPONSIBILITY (3)

438. RHETORIC OF DOCUMENTARY (3)

440W. SYSTEMS AND THEORIES OF HUMAN COMMUNICATION (3)

450W. GROUP COMMUNICATION THEORY (3)

452. ORGANIZATIONAL COMMUNICATION (3)

455. (WMNST) GENDER ROLES IN COMMUNICATION (3)

460. FOUNDATIONS OF RHETORICAL THEORY (3)

470. NONVERBAL COMMUNICATION (3)

471. CROSS-CULTURAL COMMUNICATION (3)

475. STUDIES IN PUBLIC PERSUASION (3)

478. CONTEMPORARY AMERICAN POLITICAL RHETORIC (3)

480. ORAL TRADITION OF INTERPRETATION (3)

481. COMPUTER APPLICATIONS TO COMMUNICATIONS STUDIES (3)

482W. INTRODUCTION TO APPLIED LINGUISTICS (3)

484. LINGUISTIC STRUCTURES FOR ENGLISH AS A SECOND LANGUAGE (3)

*No graduate credit is given for this course.

485. ADVANCED ORAL INTERPRETATION OF LITERATURE (3)
 490. PSYCHOLOGY OF SPEAKING AND LISTENING (3)
 491. THEORY: SECOND LANGUAGE ACQUISITION (3)
 492. DEVELOPMENT OF COMMUNICATION BEHAVIOR IN CHILDREN (3)
 493. TEACHING OF ENGLISH AS A SECOND LANGUAGE (3)
 494. RESEARCH TOPIC (1–12)
 495. SPEECH COMMUNICATION INTERNSHIP (1–18)
 496. INDEPENDENT STUDIES (1–18)
 - 497, 498. SPECIAL TOPICS (1–9)
 499. FOREIGN STUDY—SPEECH COMMUNICATION (1–9)
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500. SEMINAR IN HISTORICAL CRITICISM (2–6) Application of principles of rhetorical criticism to significant oral communications of the past.
 501. (COMM) PROSEMINAR IN MASS COMMUNICATIONS (3 per semester) Overview of paradigms in mass communications research. Prerequisite: admission to doctoral program.
 502. COMMUNICATION THEORY AND RESEARCH (3) Research design, thesis proposals, and background for research in graduate study. Prerequisites: 6 credits at the 400 or 500 level in speech communication, clinical speech, or theatre arts.
 503. SEMINAR IN CRITICISM (3 per semester, maximum of 6) Study of philosophies and methods available for the critical analysis of rhetorical transactions. Prerequisite: SPCOM 412.
 505. HISTORICAL DEVELOPMENT OF RHETORICAL THEORY (3 per semester, maximum of 9) Study of one or more periods of rhetorical theory from Greek antiquity to 1900. Prerequisite: SPCOM 412.
 506. CONTEMPORARY RHETORICAL THEORY (3 per semester, maximum of 6) A study of rhetorical theory from 1930 to the present, focusing on semantic, political, sociological, symbolic, and philosophical perspectives. Prerequisites: SPCOM 412, 505.
 507. SEMINAR IN RHETORICAL THEORY BUILDING (3–6) Investigation of selected frameworks for explaining rhetorical phenomena; examination of underlying assumptions; application to theory building in rhetoric. Prerequisite: SPCOM 420 or 460.
 509. PROBLEMS IN RHETORIC AND COMMUNICATION (3–12) Theoretical, analytical, and critical problems of human communication, with application of humanistic and social scientific research framework. Prerequisites: 6 credits in speech communication.
 510. PROBLEMS IN SPEECH EDUCATION (2–4) Advanced knowledge, theories, and principles, together with their philosophical, scientific, clinical, artistic, and educational implications for the teacher of speech. Prerequisites: SPCOM 502 and 9 additional credits at the 400 or 500 level in speech communication, clinical speech, or theatre arts.
 515. SEMINAR IN RHETORIC AND MEDIA (3) Seminar in the application of rhetorical theory and criticism to special problems of communication in television, film, and other media.
 520. SEMINAR IN SPEECH SCIENCE (3–6) Seminar in physical and physiological bases of speech and voice; introduction to laboratory techniques used in speech research. Prerequisites: 9 credits in speech communication, speech pathology and audiology, or psychology.
 522. (CMDIS) SPEECH PERCEPTION (3) Transformation of linguistic units into acoustic speech signals, theories of speech perception, and auditory processing of the speech signal. Prerequisites: SPCOM 410, 431, 520.
 530. POLITICAL COMMUNICATION AND MEDIA (3) Study of rhetorical and communicative dimensions of contemporary political communication with particular attention to electronic media.
 540. SEMINAR IN TELECOMMUNICATIONS (3) Study of the historical and contemporary issues and problems in telecommunications.
 550. SEMINAR IN ORAL PERSUASION (3 per semester, maximum of 6) Theory and devices of persuasion; analysis of persuasive discourse. Prerequisites: 6 credits in speech communication including SPCOM 100.
 551. (LING) LINGUISTIC ANALYSIS OF A NON-INDO-EUROPEAN LANGUAGE (3) An investigation into the phonological, morphological, syntactic, and discourse structures of a selected non-Indo-European language. Prerequisite: LING 400 or 403 or SPCOM 484.
 552. SEMINAR IN MICRO AND MACRO APPROACHES TO ORGANIZATIONAL COMMUNICATION (2–4) Communication perspectives as they relate to micro issues of organizational behavior and macro theories of organizational sociology.
 554. SEMINAR IN SMALL GROUP COMMUNICATION (3 per semester, maximum of 6) Communication variables in small groups. Experimental research and innovations in communication in vocational, therapeutic, and educational groups.

555. SEMINAR IN INTERPERSONAL COMMUNICATION (3 per semester, maximum of 6) Investigation of the communicative management of ongoing relationships; examination of how communication both creates and responds to the exigencies of friendship. Prerequisite: SPCOM 403 or 440.
570. SEMINAR IN NONVERBAL COMMUNICATION (3) An advanced seminar for students planning to teach or do research in human nonverbal communication. Prerequisite: SPCOM 470.
571. CROSS-CULTURAL COMMUNICATION (3) Detailed investigation into cross-cultural communication, focusing on differences in systems and potential areas of miscommunication. Prerequisite: SPCOM 470 or 491 or 493.
572. COMMUNICATION IN SECOND-LANGUAGE CLASSROOMS (3) The study of communication in second-language classrooms. Prerequisite: SPCOM 491 or 493.
581. ANALYSIS OF ORAL DISCOURSE (3) An inquiry into the role of context on the form and meaning of oral discourse. Prerequisites: SPCOM 482.
583. METHODS OF LANGUAGE ASSESSMENT (3) Introduces methodology for selecting, developing, applying, and analyzing tests and questionnaires for research and evaluation in communication and language education. Prerequisite: SPCOM 401.
590. COLLOQUIUM (1-3)
591. SEMINAR IN SECOND-LANGUAGE ACQUISITION (3) Advanced research in theoretical and experimental issues in second-language acquisition. Prerequisite: SPCOM 491.
593. RESEARCH PROBLEMS IN ENGLISH AS A SECOND LANGUAGE (3) A detailed investigation into specific areas of research in English as a second language. Prerequisite: SPCOM 493.
594. RESEARCH TOPICS (1-12) Supervised student activities on research projects identified on an individual or small-group basis. Prerequisite: prior approval of proposed assignment by instructor.
595. INTERNSHIP (1-9)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

STATISTICS (STAT)

JAMES L. ROSENBERGER, *Head of the Department*
326 Classroom Building
814-865-1348

Degrees Conferred: Ph.D., M.S., M.A.

The Graduate Faculty

Michael G. Akritas, Ph.D. (Wisconsin) *Professor of Statistics*
Charles E. Antle, Ph.D. (Oklahoma State) *Professor Emeritus of Statistics*
Steven E. Arnold, Ph.D. (Stanford) *Professor of Statistics*
Gutti J. Babu, Ph.D. (India) *Professor of Statistics*
Marllyn T. Boswell, Ph.D. (California, Riverside) *Associate Professor Emeritus of Statistics*
Vernon M. Chinchilli, Ph.D. (North Carolina) *Professor of Biostatistics and Statistics*
Janice A. Derr, Ph.D. (Washington U.) *Senior Research Associate in Statistics*
Duncan Fong, Ph.D. (Purdue) *Associate Professor of Management Science and Statistics*
Mark Handcock, Ph.D. (Chicago) *Associate Professor of Statistics*
William L. Harkness, Ph.D. (Michigan State) *Professor of Statistics*
Robert A. Hultquist, Ph.D. (Oklahoma State) *Professor Emeritus of Statistics*
Bing Li, Ph.D. (Chicago) *Associate Professor of Statistics*
Dennis K. J. Lin, Ph.D. (Wisconsin) *Professor of Management Science and Statistics*
Bruce G. Lindsay, Ph.D. (Washington) *Distinguished Professor of Statistics*
Martina Morris, Ph.D. (Chicago) *Professor of Sociology and Statistics*
Zhen Luo, Ph.D. (Wisconsin) *Assistant Professor of Statistics*
Susan A. Murphy, Ph.D. (North Carolina) *Adjunct Associate Professor of Statistics*
J. Keith Ord, Ph.D. (London) *David H. McKinley Professor of Business Administration and Professor of Statistics*
Ganapati P. Patil, Ph.D., D.Sc. (Michigan) *Distinguished Professor of Mathematical Statistics*
Calyampudi R. Rao, Sc.D. (Cambridge) *Professor and Holder of the Eberly Family Chair in Statistics*
James L. Rosenberger, Ph.D. (Cornell) *Professor of Statistics*
Thomas A. Ryan, Jr., Ph.D. (Cornell) *Associate Professor of Statistics*
Joseph L. Schafer, Ph.D. (Harvard) *Assistant Professor of Statistics*

Arkady A. Tempelman, D.Sc. (Vilnius, Lithuania) *Professor of Statistics and Mathematics*
 Steven K. Thompson, Ph.D. (Oregon State) *Associate Professor of Statistics*

Graduate instruction and research opportunities are available in most areas of statistics and probability, including linear models, nonparametric statistics, robustness, statistical computing, analysis of count data, multivariate analysis, experimental design, reliability, stochastic processes and probability (applied and theoretical), distribution theory, statistical ecology, and biometrics.

Graduate students can gain practical experience in the application of statistical methodology through participation in the department's statistical consulting center and collaborative research activities. In addition, collaborative projects with other departments provide longer term experience and support for selected students. Most students gain valuable teaching experience by assisting in the teaching and grading of courses. In addition, Ph.D. candidates with proper qualifications can receive support for teaching undergraduate courses.

Admission Requirements

Scores from the Graduate Record Examination (GRE), or from a comparable substitute examination accepted by a graduate program and authorized by the dean of the Graduate School, are required for admission. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

While applications from all students (including those who already have done graduate work) are reviewed, completion of a standard calculus sequence is regarded as a prerequisite. Students with a 3.00 or better junior/senior average (on a 4.00 scale) and with appropriate course backgrounds will be considered for admission. The best-qualified applicants will be accepted up to the number of spaces that are available for new students. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests.

Entering graduate students in statistics for whom English is not the first language are required to have a score of at least 550 on the TOEFL (Test of English as a Foreign Language) examination. The results of this examination must be received by the Department of Statistics at least six months prior to the requested date of admission to the Graduate School.

Degree Requirements

For the M.A. and M.S. degrees, a candidate must complete at least 30 credits, including at least 27 at the 500 level; 21 of the 27 500-level credits must be formal course work from the department of Statistics. A candidate must complete 6 credits in applied statistics (STAT 511, 512), 6 credits in mathematical statistics (STAT 513, 514), 3 credits in stochastic processes (STAT 515) and 3 credits in statistical consulting (STAT 580). The student must also pass a written master's qualifying examination taken at the end of the first year. Finally, an M.A. candidate must submit an acceptable master's paper to the department, and an M.S. candidate must submit a thesis.

In addition to the course requirements given above, a Ph.D. candidate in Statistics must complete further courses in linear models (STAT 551), statistical inference (STAT 561, 562), and abstract probability (STAT 517, 518). The student also must pass a written Ph.D. qualifying exam typically during the second year, and an oral comprehensive exam given at the end of the third year. The candidate then must submit an acceptable Ph.D. thesis and defend it.

If the student elects an option in the Ph.D. program, then the above requirements apply except that STAT 517, 518 is not required. However, the candidate must take 15 credits from a list of courses identified by the options in biometrics, biostatistics, environmental statistics, genometrics, or management science.

Other Relevant Information

Students in the Statistics program may elect the dual-title degree program option in Operations Research for the Ph.D. and M.S. degrees. (See also Operations Research.)

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*. GRE scores are required for consideration for assistantships.

STATISTICS (STAT)

401. EXPERIMENTAL METHODS (3)

414. (MATH) INTRODUCTION TO PROBABILITY THEORY (3)

415. (MATH) INTRODUCTION TO MATHEMATICAL STATISTICS (3)

416. (MATH) STOCHASTIC MODELING (3)
418. (MATH) PROBABILITY (3)
451. INTRODUCTION TO APPLIED STATISTICS (3)
460. INTERMEDIATE APPLIED STATISTICS (3)
462. APPLIED REGRESSION ANALYSIS (3)
464. APPLIED NONPARAMETRIC STATISTICS (3)
470. PROBLEM SOLVING AND COMMUNICATION IN APPLIED STATISTICS (3)
480. INTRODUCTION TO STATISTICAL PROGRAM PACKAGES (1)
496. INDEPENDENT STUDIES (1-18)
497. SPECIAL TOPICS (1-9)
499. FOREIGN STUDIES (1-12)
500. APPLIED STATISTICS (3) Descriptive statistics, hypothesis testing, power, estimation, confidence intervals, regression, one- and two-way ANOVA, chi-square tests, diagnostics. Prerequisite: one undergraduate course or equivalent.
501. REGRESSION METHODS (3) Analysis of research data through simple and multiple regression and correlation; polynomial models; indicator variables; step-wise, piece-wise, and logistic regression. Prerequisite: 6 credits of statistics or STAT 451 or 500; matrix algebra.
502. ANALYSIS OF VARIANCE AND DESIGN OF EXPERIMENTS (3) Analysis of variance and design concepts; factorial, nested, and unbalanced data; ANCOVA; blocked, Latin square, split-plot, repeated measures designs. Prerequisite: STAT 462 or 501.
503. DESIGN OF EXPERIMENTS (3) Design principles; optimality; confounding in split-plot, repeated measures, fractional factorial, response surface, and balanced/partially balanced incomplete block designs. Prerequisites: STAT 502; STAT 462 or 501.
504. ANALYSIS OF DISCRETE DATA (3) Models for frequency arrays; goodness-of-fit tests; two-, three-, and higher-way tables; latent and logistics models. Prerequisites: STAT 460, 502, or 512; matrix algebra.
505. APPLIED MULTIVARIATE STATISTICAL ANALYSIS (3) Analysis of multivariate data; T^2 -tests; partial correlation; discrimination; MANOVA; cluster analysis; regression; growth curves; factor analysis; principal components; canonical correlations. Prerequisites: 6 credits in statistics; matrix algebra.
506. SAMPLING THEORY AND METHODS (3) Theory and application of sampling from finite populations. Prerequisites: calculus; 3 credits in statistics.
508. APPLIED STATISTICAL DISTRIBUTION THEORY (3) Analysis of data involving nonnormal families of distributions; model building and selection, parameterizations, inferential algorithms, transformations, simulations, displays, interpretations. Prerequisites: STAT 401 or 409.
509. BIostatistical METHODS (3) An introduction to the design and statistical analysis of randomized and observational studies in biomedical research. Prerequisite: STAT 451 or 500.
510. APPLIED TIME SERIES ANALYSIS (3) Identification of models for empirical data collected over time. Use of models in forecasting. Prerequisite: STAT 462, 501, or 511.
511. REGRESSION ANALYSIS AND MODELING (3) Multiple regression methodology using matrix notation; linear, polynomial, and nonlinear models; indicator variable; AOV models; piece-wise regression, autocorrelation; residual analyses. Prerequisite: STAT 451 or 500, or 6 credits of statistics; matrix algebra, calculus.
512. DESIGN AND ANALYSIS OF EXPERIMENTS (3) AOV, unbalanced, nested factors; CRD, RCBD, Latin squares, split-plot, and repeated measures; incomplete block, fractional factorial, response surface designs; confounding. Prerequisite: STAT 511.
513. THEORY OF STATISTICS I (3) Probability models, random variables, expectation, generating functions, distribution theory, limit theorems, parametric families, exponential families, sampling distribution. Prerequisite: MATH 230.
514. THEORY OF STATISTICS II (3) Sufficiency, completeness, likelihood, estimation, testing, decision theory, Bayesian inference, sequential procedures, multivariate distributions and inference, nonparametric inference. Prerequisite: STAT 513.
515. STOCHASTIC PROCESSES I (3) Conditional probability and expectation, Markov chains, the exponential distribution and Poisson processes. Prerequisite: MATH (STAT) 414 or STAT 513.
517. (MATH) PROBABILITY THEORY I (3) Measure theoretic foundation of probability, distribution functions and laws, types of convergence, central limit problem, conditional probability, special topics. Prerequisite: MATH 403.
518. (MATH) PROBABILITY THEORY II (3) Measure theoretic foundation of probability, distribution functions and laws, types of convergence, central limit problem, conditional probability, special topics. Prerequisite: MATH 403.

519. (MATH) TOPICS IN STOCHASTIC PROCESSES (3) Selected topics in stochastic processes, including Markov and Wiener processes; stochastic integrals, optimal filtering. Prerequisites: STAT (MATH) 516, 517.
524. ECOMETRICS (3) Stochastic models and statistical methods in ecological problems; population dynamics, spatial patterns in populations of one, two, or more species. Prerequisite: STAT (MATH) 414 or STAT 418.
525. SURVIVAL ANALYSIS I (3) Location estimation, 2- and k-sample problems, matched pairs, tests for association and covariance analysis when the data are censored. Prerequisites: STAT 512, 514.
526. SURVIVAL ANALYSIS II (3) Asymptotic theory for Kaplan-Meier estimator, 2- and k-sample rank tests, rank regression, proportional hazards regression. Advanced special topics. Prerequisite: STAT 525.
527. (BIOL) QUANTITATIVE ECOLOGY (3) Introduction to quantitative population and community ecology, with emphasis on problems, concepts, and methods using mathematical, statistical, and computational analysis. Prerequisites: STAT (MATH) 318 or 414, BIOL 210.
528. (BIOL) STATISTICAL ECOLOGY SPECTRUM (3) Overview of research and instruction of particular interest to quantitative ecology faculty in the Ecology program. Prerequisite: STAT (BIOL) 527.
540. STATISTICAL COMPUTING (3) Computational foundations of statistics; algorithms for linear and nonlinear models, discrete algorithms in statistics, graphics, missing data, Monte Carlo techniques. Prerequisites: STAT (MATH) 415; STAT 501 or 511; matrix algebra.
544. CATEGORICAL DATA ANALYSIS I (3) Two-way tables; generalized linear models; logistic and conditional logistic models; loglinear models; fitting strategies; model selection; residual analysis. Prerequisites: STAT 512, 514.
545. CATEGORICAL DATA ANALYSIS II (3) Generalized logit models; symmetry and agreement models; repeated measures; longitudinal data; delta method; asymptotic distributions; ML & WLS; advanced special topics. Prerequisite: STAT 544.
548. STATISTICAL DISTRIBUTION THEORY (3) Analytical study of nonnormal models and methods in reliability theory, survival analysis, records evaluation, scale/scale-free analysis, and directional statistics. Prerequisite: STAT (MATH) 319, 414, or 416.
551. LINEAR MODELS I (3) A coordinate-free treatment of the theory of univariate linear models, including multiple regression and analysis of variance models. Prerequisites: MATH (STAT) 415 or STAT 514; STAT 512; MATH 436 or MATH 441.
552. LINEAR MODELS II (3) Treatment of other normal models, including generalized linear, repeated measures, random effects, mixed, correlation, and some multivariate models. Prerequisite: STAT 551.
561. STATISTICAL INFERENCE I (3) Multiparameter estimation; linear estimation; maximum likelihood estimation; Bayesian estimation; large sample properties and procedure. Prerequisite: STAT 514.
562. STATISTICAL INFERENCE II (3) Testing statistical composite hypotheses; invariance principles, Bayesian statistics; large sample properties and procedures. Prerequisite: STAT 561.
564. THEORY OF NONPARAMETRIC STATISTICS (3) Estimation and testing based on nonparametric procedures for location and regression models. Distribution theory and asymptotic efficiency. Prerequisite: MATH (STAT) 415 or STAT 514.
565. MULTIVARIATE ANALYSIS (3) Theoretical treatment of methods for analyzing multivariate data, including Hotelling's T^2 , MANOVA, discrimination, principal components, and canonical analysis. Prerequisites: STAT 505, 551.
572. STATISTICAL DECISION THEORY I (3) Structure of statistical games, optimal strategies, fixed sample-size games. Prerequisite: MATH (STAT) 415 or STAT 514.
580. STATISTICAL CONSULTING PRACTICUM (1-2 per semester, maximum of 6) General principles of statistical consulting and statistical consulting experience. Preparation of reports, presentations, and communications aspects of consulting are discussed. Prerequisites: STAT 502; STAT 503, 504, or 506.
590. COLLOQUIUM (1-3)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

SYSTEMS ENGINEERING (SYSEN)

DAVID W. RUSSELL, *Head, Division of Engineering*
Penn State Great Valley School of Graduate Professional Studies
30 Swedesford Road
Malvern, PA
(610) 648-6335
On the Web: www.gv.psu.edu

Degree Conferred: M.Eng. in Systems Engineering

The Graduate Faculty

Robert M. Hartman, Ph.D. (Delaware) *Associate Professor of Mechanical Engineering*
Kathryn Jablow, Ph.D. (Ohio State) *Associate Professor of Mechanical Engineering*
Eugene Kozik, Ph.D. (Pittsburgh) *Associate Professor of Industrial and Manufacturing Engineering*
John I. McCool, Ph.D. (Temple) *Associate Professor of Industrial and Manufacturing Engineering*
David W. Russell, Ph.D. (London) *Professor of Electrical Engineering*
Lily Sehayek, Ph.D. (Rutgers) *Assistant Professor of Environmental Engineering*
James Weisbecker, Ph.D. (Temple) *Assistant Professor of Computer Science*

This professional master's degree program, available at Penn State Great Valley, deals with the various aspects of systems engineering. The program consists of four 9-credit modules of study. Each module is designed for in-depth coverage of a specific area of study (e.g., systems and control, robotics, etc.). One of the modules is required, and covers professional, skill-based topics such as business ethics and management of technology, and includes a professional paper. Graduate instruction is under the direction of an interdisciplinary faculty committee and the departments participating in the program. The graduate faculty consists of members who have teaching and research interests in the area of systems engineering. Maximum flexibility is maintained by the program in an effort to meet both the professional needs of the individual students and academic quality standards. Opportunity for student research and presentation will be given using a colloquium series.

Admission Requirements

Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the Graduate Bulletin.

The M.Eng. in Systems Engineering program is designed for students with backgrounds in science or engineering. Admission will be granted if the applicant has the necessary program prerequisites and a faculty member in the student's interest area agrees to serve as adviser. Normal admission requirements include mathematics through differential equations. Scores from the Graduate Record Examination (GRE) are not an entrance requirement unless he or she has a junior/senior grade-point average below 3.00 (on a 4.00 scale). There is no foreign language requirement.

Students with a 3.00 junior/senior average in an appropriate technical degree program will be considered for admission. The best-qualified applicants will be accepted. Exceptions to the minimum 3.00 grade-point average may be made for students with special backgrounds, abilities, and interests. Entering graduate students for whom English is not their first language are required to have a score of at least 550 on the Test of English as a Foreign Language (TOEFL) examination.

Degree Requirements

All candidates are required to take the professional, skill-based, 9-credit core module and three other 9-credit modules. At least 15 credits of selected courses must be at the 500 level.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

SYSTEMS ENGINEERING (SYSEN)

- 590. COLLOQUIUM (1-3)
- 594. MASTER'S RESEARCH (1-15)
- 596. INDIVIDUAL STUDIES (1-9)
- 597. SPECIAL TOPICS (1-9)

TEACHING AND CURRICULUM (T & C)

STEVEN A. MELNICK, *Coordinator of the Graduate Program in Teaching and Curriculum*
Penn State Harrisburg
Middletown, PA 17057
717-948-6213

Degree Conferred: M.Ed.

The Graduate Faculty

Richard I. Ammon, D.Ed. (Penn State) *Associate Professor of Education*
Steven M. Barnes, Ph.D. (Michigan State) *Assistant Professor of Education*
Diane M. Bottomley, Ph.D. *Assistant Professor of Education and Reading*
Gregory Coverdale, Ph.D. (Michigan State) *Assistant Professor of Science Education*
Ernest K. Dishner, Ph.D. (Georgia) *Professor of Education and Reading*
Daniele D. Flannery, Ph.D. (Wisconsin) *Assistant Professor of Education*
Betty C. Fortner, Ph.D. (Texas) *Associate Professor of Education and Reading*
William R. Freed, Ed.D. (Lehigh) *Assistant Professor of Education*
William A. Henk, Ed.D. (West Virginia) *Professor of Education and Reading*
Charles E. Jenks, Ph.D. (Georgia) *Assistant Professor of Social Studies and Education*
Barry Kanpol, Ph.D. (Ohio State) *Associate Professor of Secondary Foundations*
Robert J. Lesniak, Ph.D. (Syracuse) *Associate Professor of Education*
Denise M. Meister, Ph.D. (Penn State) *Assistant Professor of Education*
Steven A. Melnick, Ph.D. (Connecticut) *Associate Professor of Education*
Stanley M. Miller, Ed.D. (George Peabody) *Professor Emeritus of Social Sciences and Education*
Susan Hillman, Ph.D. (Delaware) *Assistant Professor of Mathematics Education*
Cheri L. Ross, Ph.D. (Purdue) *Assistant Professor of English Education and Humanities*
Ranny Singiser, D.Ed. (Penn State) *Assistant Professor of Education*
Frank J. Swetz, Ed.D. (Columbia) *Professor Emeritus of Mathematics and Education*
Coleen Willard-Holt, Ph.D. (Purdue) *Assistant Professor of Education*
Kathryn Towns, Ph.D. (Penn State) *Professor Emerita of Educational Psychology and Women's Studies*

The Master of Education in Teaching and Curriculum at Penn State Harrisburg provides to full- and part-time students a curriculum designed to develop master teachers for public and private school instruction and education specialists. In addition, specialties are available in particular areas, such as reading, urban education, curriculum, early childhood education, elementary education, and secondary English, social studies, mathematics education, and language arts.

Specifically, the goals of the program are to develop in students (1) the ability to communicate effectively either with school-age students and their parents or with coworkers and/or clients; (2) the ability to conduct an instructional program that provides a sound intellectual and emotional climate for learning; (3) competence in a variety of teaching methods and in the utilization of materials and content appropriate for an effective instructional program; (4) the ability to interpret and to evaluate educational literature and research; and (5) the ability to describe and to evaluate major issues and current trends in instructional curriculum practice and development.

Certification programs are also available in the areas of reading specialist (K-12), early childhood education, and principalship.

Admission Requirements

Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

An applicant must present a baccalaureate degree from an accredited institution with a junior/senior grade-point average of 2.50 (on a 4.00 scale). Exceptions may be made for students with special backgrounds, abilities, and interests. In such cases, students may be required to take the Graduate Record Examination (GRE), which is administered by the Educational Testing Service, and to achieve a combined score of at least 850 for the verbal and quantitative subtests. For dates, locations, and other information about the test, call the Counseling Center at Penn State Harrisburg, 717-948-6025, or write to the Educational Testing Service, Graduate Record Examination, Princeton, NJ 08540.

An applicant whose original language is not English is required to submit acceptable scores on the Test of English as a Foreign Language (TOEFL). A score of 550 is required. The scores must be submitted before the application will be considered.

Degree Requirements

A total of 36 credits of work normally is required. Program requirements include the following courses:

Credits

- 3 Learning Theory (EDUC 520) or (EDUC 561 Rdg. Spec. only)
- 3 Curriculum Development (EDUC 403, 482, or 506)
- 3 Measurement and Evaluation (EDUC 439) or (EDUC 562 Rdg. Spec. only)
- 3 Educational Foundations (EDUC 505, 571, 572, or 589)
- 3 Educational Research Designs (EDUC 586)
- 3 Master's Project (EDUC 587)
- 3 Literacy Assessment (EDUC 425 Rdg. Spec. only)
- 3 Whole Language (EDUC 471 Rdg. Spec. only)
- 3-12 Electives from Professional Education
- 6-15 Electives outside Professional Education

At least 15 of the 36 required credits must be 500-level credits and all course work applied to the degree must be 400-level or higher and must be completed within a seven-year period. The last 12 credits in a student's program must be earned at Penn State Harrisburg.

A maximum of 10 credits may be transferred into this program. All transfer credits must be approved in writing by the student's adviser. Credits taken as nondegree or certification-only students are considered to be transfer credits when applied to the M.Ed. degree.

To complete the Master of Education degree, each student is required to write a master's paper or complete a master's production or practicum (EDUC 587). The proposal for this project must be presented to the professor selected to supervise the work and must be approved at least one full semester before the semester in which the student completes the requirements for the degree. The master's project must be written under the guidance and direction of the student's committee. Papers written as course requirements are not acceptable as master's papers.

A minimum grade-point average of 3.00 for work done at the University is required for graduation.

EDUCATION (EDUC)

- 401. EARLY CHILDHOOD EDUCATION (3)
- 402. LANGUAGE DEVELOPMENT, SELF-EXPRESSION, AND LITERATURE IN EARLY CHILDHOOD EDUCATION (3)
- 403. CURRICULUM FOR EARLY CHILDHOOD (3)
- 404. YOUNG CHILDREN'S BEHAVIOR: OBSERVATION AND EVALUATION (3)
- 405. EARLY CHILDHOOD EDUCATION: INFANCY AND TODDLERHOOD (3)
- 406. HUMAN SEXUALITY (3)
- 408. ADMINISTRATION OF EARLY CHILDHOOD EDUCATION PROGRAMS (3)
- 410. THE CHILD AND SOCIAL INSTITUTIONS (3)
- 412. EARLY LITERACY INTERVENTION (3)
- 413. EARLY LITERACY INTERVENTION (3)
- 415. TEACHING SECONDARY SOCIAL STUDIES (3)
- 416. TEACHING SECONDARY ENGLISH AND HUMANITIES (3)
- 417. TEACHING SECONDARY MATHEMATICS (3)
- 418. POSITIVE CLASS CLIMATE (3)
- 421. CHILDREN'S LITERATURE (3)
- 422. LITERATURE FOR CHILDREN AND ADOLESCENTS (4)
- 423. TEACHING READING TO THE LANGUAGE-DIFFERENT LEARNER (3)
- 424. FOLK AND FAIRY TALES (3)
- 425. LITERACY ASSESSMENT (3)
- 435. ADDRESSING THE NEEDS OF SPECIAL LEARNERS (3)
- 436. INCLUSION PRACTICES IN EDUCATION (3)
- 439. MEASUREMENT AND EVALUATION (3)
- 440. EDUCATIONAL STATISTICS AND MEASUREMENTS (3)
- 450. CURRENT TOPICS IN EDUCATION (1-15)
- 452. TEACHING WRITING (2)
- 460. FIELD STUDY IN ECOLOGY (3)
- 484. SCHOOL LAW FOR TEACHERS (3)
- 461. PREPARING VISUAL MEDIA (3)
- 462. COMPUTERS FOR CLASSROOM TEACHERS (3)
- 470. HIGHER-ORDER THINKING FOR EDUCATORS (3)
- 471. WHOLE LANGUAGE (3)

472. TEACHING READING THROUGH THE CONTENT AREAS (3)
476. THE EFFECTS OF ENVIRONMENT ON CHILD DEVELOPMENT (3)
495. INTERNSHIP (1-5)
496. INDEPENDENT STUDIES (1-15)
497. SPECIAL TOPICS (1-9)
501. HISTORY OF AMERICAN EDUCATION (3) An examination of the rise and transformation of American public schools from pre-Colonial America to the present.
503. CULTURAL AND ETHNIC GROUPS IN EDUCATION (3) Approaches to teaching in an environment of differing cultures and ethnic groups. Prerequisite: approval of program.
505. CURRICULUM FOUNDATIONS (3) Study of the philosophical, cultural, social, and human developmental sources and implications of the school curriculum.
506. CURRICULUM DEVELOPMENT (3) Examination of theory, issues, organization, and local school problems of curriculum development.
508. TEACHING GIFTED STUDENTS IN HETEROGENEOUS GROUPS (3) The course is designed to help regular classroom teachers meet the needs of gifted students in a heterogeneous classroom. Prerequisite: permission of program.
520. LEARNING THEORY (3) Presents learning theories from the psychological, sociological, and physiological disciplines and applies them to personal and educational learning.
560. CLASSROOM MANAGEMENT (3) Analysis of teaching styles, classroom behavior and interaction, organization and correlation of classroom activities and subject areas. (Requires practical application in an actual teaching situation.)
561. PSYCHOLOGY OF READING (3) Examination of the theoretical bases for reading which have direct practical implication for teaching reading. Prerequisites: EDUC 320, 321.
562. DIAGNOSTIC EVALUATION OF READING PROBLEMS (3) Utilization of formal and informal instruments and techniques appropriate in analyzing reading disabilities, grades K through 12; includes practicum. Prerequisite: EDUC 321.
563. ADVANCED METHODS IN TEACHING READING (3) Advanced development of diagnostic and instructional techniques for teaching reading, with emphasis on individual and small group instruction. Prerequisite: EDUC 321.
564. READING CLINIC (5) Culminating course for the M.Ed. degree in reading requiring competency demonstrations in working with children possessing reading problems. Prerequisites: EDUC 422, 452, 561, 562, 563, BE SC 405, 406.
565. LITERACY LEADERSHIP (3) Study of the administrative functions of reading supervisors including topics such as scheduling, organizing, administering, and evaluating reading programs.
571. GREAT TEACHERS (3) Study of one or more great teachers, e.g., Socrates, Comenius, Locke, Rousseau, Pestalozzi, Herbart, Froebel, Dewey, Kilpatrick.
572. COMPARATIVE EDUCATION: WORLD PERSPECTIVES (3) An evaluative comparison of American education with Western and non-Western educational systems.
583. PROBLEMS IN TEACHING: SELECTED SUBJECT AREAS (3) An analysis of a teaching problem with review of research literature to seek solutions to that problem. Prerequisite: consent of adviser.
584. ANALYSIS OF RESEARCH: SELECTED TOPICS (3) A review and analysis of research in a specified area. Prerequisite: EDUC 586 or consent of adviser.
586. EDUCATIONAL RESEARCH DESIGNS (3) Identification of research designs appropriate to educational field and laboratory investigations and the development of a master's project proposal. Prerequisites: 15 credits in graduate study.
587. MASTER'S PROJECT (3) The development of an original master's project (paper, essay, production, practicum) supervised and judged by an appropriate faculty committee. Prerequisite: consent of adviser.
589. PROBLEMS IN URBAN EDUCATION (3) Independent study of selected topics related to urban education.
590. COLLOQUIUM (1-3)
591. EDUCATION SEMINAR (1-6) The capstone seminar course for the M.Ed. degree requiring an appropriate scholarly term paper.
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

TEACHING ENGLISH AS A SECOND LANGUAGE (TESL)

SANDRA J. SAVIGNON, *Director, Program in English as a Second Language*
305 Sparks Building
814/865-7365

Degree Conferred: M.A.

The Graduate Faculty

Grant Henning, Ph.D. (UCLA), *Professor of Speech Communication*
Karen E. Johnson, Ph.D. (Syracuse), *Associate Professor of Speech Communication*
Sandra J. Savignon, Director, Ph.D. (Illinois, Urbana-Champaign), *Professor of Speech Communication*

The master's program in English as a Second Language is designed to provide advanced training for teachers and administrators in English as a second or foreign language. The program is problem focused, integrating theory and practice from the fields of applied linguistics, communication, educational technology, and psychology to address issues of second language acquisition/teaching and program development with special focus on English in a wide range of both domestic and international contexts. Requirements include 36 credit hours, a master's paper, and a comprehensive written examination.

Completion of this degree program does not automatically provide teacher certification in the Commonwealth of Pennsylvania. Further information on teaching certification is available from the College of Education. Students who desire to continue their studies in ESL at Penn State may be admitted to the Ph.D. program in Speech Communication with an emphasis in TESL.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are required for admission. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Applicants whose native language is not English must take the TOEFL examination and attain a score greater than 600. All applicants are also required to arrange for three letters of reference to be submitted along with a one to two page statement of the applicant's goals and professional objectives.

Degree Requirements

The M.A. in TESL requires 36 credits, of which 18 credits must consist of 500-level courses. In lieu of a thesis, students must prepare a master's paper and pass a comprehensive examination. The following courses are required: SPCOM 491, SPCOM 493, SPCOM 571 or 572, SPCOM 595; SPCOM 410, 482, 484; 9 credits of electives from the following SPCOM courses: SPCOM 583, 593, 597; and 6 credits of approved electives.

Student Aid

Graduate Assistantships that may be available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

TELECOMMUNICATIONS STUDIES (TELEC)

RICHARD L. BARTON, *Associate Dean for Graduate Studies*
College of Communications
201 Carnegie Building
814-865-3070

Degree Conferred: M.A.

Richard L. Barton, Ph.D. (Oregon) *Associate Dean; Associate Professor of Communications*;
Robert A. Baukus, Ph.D. (Massachusetts) *Associate Professor of Communications*
R. Thomas Berner, M.A. (Penn State) *Professor of Journalism and American Studies*
Ronald Bettig, Ph.D. (Illinois) *Assistant Professor of Communication*
Barbara Bird, M.F.A. (Northwestern) *Assistant Professor of Communications*

Clay Calvert, Ph.D. (Stanford) *Assistant Professor of Communications and Law*
 Jeremy Cohen, Ph.D. (Washington) *Interim Dean; Professor of Communications*
 Dennis K. Davis, Ph.D. (Minnesota) *Professor of Communications*
 Robert M. Frieden, J.D. (Virginia) *Professor of Communications*
 Katherine T. Frith, Ed.D. (Massachusetts) *Associate Professor of Advertising*
 Jeanne Hall, Ph.D. (Wisconsin) *Assistant Professor of Media Studies*
 M. Heather Hartley, M.F.A. (Ohio) *Assistant Professor of Communications*
 R. Dorn Hetzel, M.F.A. (New York) *Associate Professor of Film and Video*
 Anne Hoag, Ph.D. (Michigan) *Assistant Professor of Communications*
 Chris Jordan, Ph.D. (New Mexico) *Assistant Professor of Communications*
 Ann Marie Major, Ph.D. (Southern Illinois) *Assistant Professor of Communications*
 Mary S. Mander, Ph.D. (Illinois) *Associate Professor of Communications*
 Virginia Mansfield-Richardson, Ph.D. (Ohio) *Associate Professor of Communications*
 Charles A. McMellon, Ph.D. (CUNY) *Assistant Professor of Communications*
 Eve Stryker Munson, Ph.D. (Illinois) *Assistant Professor of Communications*
 John S. Nichols, Ph.D. (Minnesota) *Associate Professor of Communications*
 Anthony A. Olorunnisola, Ph.D. (Howard) *Assistant Professor of Communications*
 Patrick R. Parsons, Ph.D. (Minnesota) *Associate Professor of Communications*
 Daniel W. Pfaff, Ph.D. (Minnesota) *Professor of Journalism*
 Robert D. Richards, J.D. (American) *Associate Professor of Communications and Law*
 Ford Risley, Ph.D. (Florida) *Assistant Professor of Communications*
 Shari Roberts, Ph.D. (Chicago) *Assistant Professor of Communications*
 Jorge Reina Schement, Ph.D. (Stanford) *Professor of Communications*
 Shyam Sundar Sethuraman, Ph.D. (Stanford) *Assistant Professor of Communications*
 E. Stratford Smith, M.L. (George Washington) *Cable TV Pioneer Chair Professor in Telecommunications Studies and Law*
 Susan M. Stroh, Ph.D. (Minnesota) *Assistant Professor of Communications*
 Richard D. Taylor, J.D. (New York) *Palmer Professor of Telecommunications Studies*
 W. Bradley Thompson, Ph.D. (Colorado) *Assistant Professor of Communications*

The Master's in Telecommunications Studies program offers a comprehensive approach to understanding the convergence and globalization of media and telecommunications and the rise of the global media enterprise. It includes relevant history, technology, law and regulation, and industrial structures. The program is for students who (1) have an undergraduate degree in communications or a related field and wish to pursue more advanced study and (2) persons employed in telecommunications and media industries, or engaged in the regulation of such industries, who wish to broaden their perspectives across the field and attain a more comprehensive vision of telecommunications development. Persons with undergraduate degrees in other fields or persons seeking to change careers may be required by the committee to acquire certain basic knowledge of the field, and admission will be based on a case-by-case review.

Admission Requirements

Applicants must submit GRE and TOEFL (for international students for whom English is a second language) scores. The minimum TOEFL admittance score is 600. Applicants with an undergraduate 3.00 junior/senior grade-point average (on a 4.00 scale) are eligible for admission. Also required are three letters of recommendation and an autobiographical statement of 750 to 1,000 words indicating the nature of the applicant's interest in undertaking graduate study in telecommunications.

Program of Study

The M.A. in Telecommunications Studies program is a two-academic-year, 36-credit program that requires a 6-credit master's paper. A student must enter the program in the fall semester.

Degree Requirements

Candidates must complete a minimum of 36 credits (including master's paper preparation): no more than 9 credits at the 400 level and no more than 6 credits in independent study (in addition to 6 credits researching and writing a master's paper). Candidates must complete a 9-credit core. The remaining credits are selected by the student in consultation with the adviser. Course work offered by departments outside the College of Communications may be scheduled as part of the student's program with prior approval of the student's academic committee. A candidate must maintain 3.00 grade-point average and complete a significant research paper (master's paper) under the direction of a faculty adviser. This paper shall be reviewed and approved by a faculty committee of at least three members. Students are required to schedule three

THEATRE ARTS

separate, formal meetings with their advisers and academic committees for (1) discussion and approval of the general program plan, (2) the paper proposal, and (3) the review of the paper.

Student Aid

Graduate assistantship and other forms of student aid available to students in the program are described in the STUDENT AID section of the *Graduate Bulletin*.

COMMUNICATIONS (COMM)

For a complete list of course descriptions, see Media Studies.

- 405. POLITICAL ECONOMY OF COMMUNICATIONS' (3)
- 407. ADVERTISING IN THE AMERICAN ECONOMY (3)
- 417. ADVERTISING REGULATION AND ETHICS (3)
- 409. WORLD MEDIA SYSTEMS (3)
- 483. TELECOMMUNICATIONS REGULATION (3)
- 484. EMERGING TELECOMMUNICATIONS TECHNOLOGIES (3)

- 504. SEMINAR IN THE HISTORY OF MASS COMMUNICATIONS (3)
- 505. INTERNATIONAL COMMUNICATIONS PROBLEMS (3)
- 510. COMPARATIVE THEORIES OF PRESS SYSTEMS (3)
- 512. GOVERNMENT AND MASS COMMUNICATIONS (3)
- 513. CONSTITUTIONAL PROBLEMS AND THE NEWS MEDIA (3)
- 520. SEMINAR IN ADVERTISING PROBLEMS (3)
- 553. SPECIAL TOPICS IN FILM AND TELEVISION (3)
- 580. SEMINAR IN TELECOMMUNICATIONS (3)
- 581. HISTORY OF ELECTRICAL, ELECTRONIC, AND OPTICAL COMMUNICATIONS (3)
- 582. ETHICS AND EMERGING COMMUNICATIONS TECHNOLOGY (3)
- 583. SEMINAR ON U.S. TELECOMMUNICATIONS POLICY (3)
- 596. INDIVIDUAL STUDIES (1-9)
- 597. SPECIAL TOPICS (1-9)

THEATRE ARTS (THEA)

RICHARD NICHOLS, *Head of the Graduate Program in Theatre Arts*
123 Arts Building
814-863-1455

Degree Conferred: M.F.A.

The Graduate Faculty

Danny H. Carter, M.F.A. (Illinois State) *Professor of Theatre Arts*
Douglas N. Cook, M.A. (Stanford) *Professor Emeritus of Theatre Arts*
Travis DeCastro, M.F.A. (Utah) *Associate Professor of Theatre Arts*
Suzanne S. Elder, M.F.A. (Texas, Austin) *Assistant Professor of Theatre Arts*
Mark Fearnow, Ph.D. (Indiana, Bloomington) *Associate Professor of Theatre Arts*
Charles H. Firmin, M.F.A. (Penn State) *Associate Professor of Theatre Arts*
John C. Franceschina, M.F.A. (Catholic Univ.) *Associate Professor of Theatre Arts*
Anne A. Gibson, M.F.A. (Carnegie Mellon) *Professor of Theatre Arts*
Richard D. Gray, M.F.A. (Penn State) *Associate Professor of Theatre Arts*
William J. Kelly, M.F.A. (Penn State) *Associate Professor of Theatre and Integrative Arts*
Barry M. Kur, M.A. (SUNY) *Associate Professor of Theatre Arts*
Robert E. Leonard, M.F.A. (Goodman School of Drama) *Professor of Theatre Arts*
Cary Libkin, M.F.A. (Carnegie Mellon) *Associate Professor of Theatre Arts*
Helen A. Manfull, Ph.D. (Minnesota) *Professor Emerita of Theatre Arts*
Lowell Manfull, Ph.D. (Minnesota) *Professor Emeritus of Theatre Arts*
Douglas R. Marmee, M.F.A. (Brandeis) *Associate Professor of Theatre Arts*
Annette K. McGregor, Ph.D. (Oregon) *Assistant Professor of Theatre Arts*
Richard Nichols, Ph.D. (Washington) *Professor of Theatre Arts*
Mark Olsen, B.A. (Trinity) *Associate Professor of Theatre Arts*
Jane Ridley, M.F.A. (Ohio State) *Associate Professor of Theatre Arts*
Daniel Robinson, M.F.A. (Missouri, Kansas City) *Associate Professor of Theatre Arts*

This program pursues the following objectives: (1) to assist each student in acquiring discriminating taste and critical judgment in theatre arts; (2) to help each student attain skills and proficiencies in theatre arts; (3) to provide the training, discipline, and opportunities essential to the development of a professional ability in at least one area of theatre arts; and (4) to prepare each student for an active career in academic, professional, and/or community theatre.

Department facilities include the Playhouse, a 450-seat proscenium thrust theatre; the Pavilion, a 249-seat arena or three-quarter theatre; theatre production studios for scenic, property, and costume preparation; a computer-assisted design laboratory; a lighting laboratory; a sound and media studio; a makeup studio; and rehearsal and dance studios. Adjunct facilities include the 2,600-seat Eisenhower Auditorium, the 1,000-seat Schwab Auditorium, and the 550-seat Recital Hall.

Admission Requirements

Graduate Record Examination (GRE) scores, or comparable examination scores, are not required for admission to the Department of Theatre Arts. However, students with excellent academic records who may wish to be considered for fellowships should take the GRE as a matter of course. Those who do not qualify for fellowship competition may use GRE scores to supplement the admission application. Requirements listed here are in addition to general Graduate School requirements stated in the *Graduate Bulletin*.

Requirements for admission to the M.F.A. program are (1) a broad undergraduate preparation in theatre, including 3 credits each in acting, directing, stagecraft, and theatre history; and 6 credits of dramatic literature; (2) 12 credits in related subject areas such as communications, oral interpretation, art, business, music, and dance; and (3) submission of a vita and at least three letters of recommendation.

Additional requirements for M.F.A. candidates are (1) submission of evidence of professional potential in the proposed area of specialization—auditions, prompt books, portfolios, manuscripts, and other appropriate presentations—to the applicable study program(s) by arrangement with the department; and (2) a personal interview to be arranged by the student.

Master of Fine Arts Degree Requirements

The program entails specialized professional training in one of the following areas: acting, directing, scene design, costume design, costuming, lighting design and technology, and technical direction. Six semesters in residence are normally required to complete the minimum 60-credit degree.

Students are evaluated on a semester-by-semester basis on academic progress, creative achievement, and professional potential. The M.F.A. is a professional degree and is granted by the Graduate Faculty on the basis of academic and creative excellence over and above the fulfillment of requirements. Satisfactory academic progress does not guarantee continuance in the program, nor does continuance in the program imply the automatic granting of a degree. M.F.A. candidates are required to participate in the University Resident Theatre Company productions in positions of responsibility. Additionally, each student must complete a committee-approved monograph project in the area of specialization.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

THEATRE ARTS (THEA)

- 400. ADVANCED THEATRE PROJECTS (1–6 per semester)
- 401. THEATRE HISTORY I: ANCIENT TO 1700 (3)
- 402W. THEATRE HISTORY II: FROM 1700 TO PRESENT (3)
- 405. THEATRE HISTORY: AMERICAN THEATRE (3)
- 406. THEATRE IN ASIA (3)
- 407. (DF) WOMEN AND THEATRE (3)
- 426. CHILDREN'S THEATRE (3)
- 428. CREATIVE DRAMA (3)
- 429. THEATRE PERFORMANCE PRACTICUM (1–3 per semester)
- 434. INTRODUCTION TO DIRECTING (3)
- 435. ADVANCED SCRIPT ANALYSIS AND FUNDAMENTALS OF STAGING (3)
- 436. DIRECTORIAL PROCESSES (3)
- 437. ARTISTIC STAFF FOR PRODUCTION (1–6)
- 439. PROJECTS IN DIRECTING (1)
- 440. PRINCIPLES OF PLAYWRITING (3)
- 447. MAKEUP DESIGN FOR PRODUCTION (3)

THEATRE ARTS

450. SCENIC DESIGN II (3 per semester, maximum of 6)
453. ADVANCED SCENE PAINTING (1 per semester, maximum of 12)
457. SCENE DESIGN FOR PRODUCTION (1 per semester, maximum of 6)
460. COSTUME DESIGN II (3)
461. COSTUME CONSTRUCTION II (3)
466. COSTUME DESIGN FOR PRODUCTION (1 per semester, maximum of 6)
467. COSTUME DESIGN FOR PRODUCTION (1 per semester, maximum of 6)
470. LIGHTING DESIGN II (3)
477. LIGHTING DESIGN FOR PRODUCTION (1 per semester, maximum of 6)
480. TECHNICAL PRODUCTION II (3)
481. STAGE AND PRODUCTION MANAGEMENT (3)
485. SOUND FOR THEATRE PRODUCTION (3)
487. TECHNICAL PROJECTS FOR PRODUCTION (1 per semester, maximum of 6)
489. THEATRE PRODUCTION PRACTICUM (1 per semester)
495. INTERNSHIP PRACTICUM (1–6 per semester, maximum of 12)
496. INDEPENDENT STUDIES (1–18)
497. SPECIAL TOPICS (1–9)
499. FOREIGN STUDIES—THEATRE (1–12)
500. THEATRE RESEARCH: SOURCES AND PROCEDURE (3) Source materials and techniques as applied to theatre research; the form and content of theses and monographs.
501. PRODUCTION PROCESS (3) Exploration and development of the creative processes that lead to realized production. Prerequisite: M.F.A. theatre design and technology students.
502. CREATIVE COLLABORATION (3) Theory and process of creative collaboration between the theatre artistic and production staffs. Prerequisite: M.F.A. theatre candidate.
503. THEATRE CRITICISM AND THEORY I (3) Examining significant document of theory/criticism from Greek theatre to Collier. Theory applied to specific plays within that period. Prerequisite: THEA 500.
504. THEATRE CRITICISM AND THEORY II (3) Examining significant documents of theory/criticism from Collier controversy to the present. Theory applied to specific plays within that period. Prerequisite: THEA 503.
505. MASTERPIECES IN PRODUCTION I (3) Dramatic structure, theatrical validity, production viability of great plays from Greek to eighteenth century. Drama as blueprint for production.
506. MASTERPIECES IN PRODUCTION II (3) Dramatic structure, theatrical validity, production viability of great plays from Buchner to the present. Drama as a blueprint for production.
507. MASTERPIECES IN PRODUCTION III (3) Dramatic structure, theatrical validity, production viability of major American plays from Tyler to the present. Drama as blueprint for production.
- 520A. ACTING I (3) Exercises, monologue, and scene study. Principal focus on realism. Prerequisite: admission to the M.F.A. performance acting program.
- 520B. MOVEMENT FOR ACTORS I (2) Techniques and skills in physical expression, awareness, control, and stage movement. Prerequisite: admission to M.F.A. performance acting program.
- 520C. VOICE AND SPEECH I (2) Vocal techniques for the actor; articulation, voice control, support, and projection. Prerequisite: admission to the M.F.A. performance acting program.
- 521A. ACTING II (3) A continuation of THEA 520A. Prerequisites: THEA 520A, 520B, 520C.
- 521B. MOVEMENT FOR ACTORS II (2) A continuation of THEA 520B. Prerequisites: THEA 520A, 520B, 520C.
- 521C. VOICE AND SPEECH II (2) A continuation of THEA 520C. Prerequisites: THEA 520A, 520B, 520C.
- 522A. ACTING III (3) Advanced exercises, monologue and scene study. Principal focus on classical repertoire. Prerequisite: THEA 521A.
- 522B. MOVEMENT FOR ACTORS III (2) Advanced techniques and skills in physical expression. Prerequisite: THEA 521B.
- 522C. VOICE AND SPEECH II (2) Advanced voice and speech training for the actor: articulation, resonance, stage dialects, scansion of verse drama. Prerequisite: THEA 521C.
- 523A. ACTING IV (3) A continuation of THEA 522A. Prerequisite: THEA 522A.
- 523B. MOVEMENT ACTORS IV (2) A continuation of THEA 522B. Prerequisite: THEA 522B.
- 523C. VOICE AND SPEECH IV (2) A continuation of THEA 522C. Prerequisite: THEA 522C.
524. ACTING V (2) Advanced scene study and class projects; development of individual student repertoires. Prerequisite: THEA 523A.
525. ACTING PROFESSIONALLY (3) Orientation to the professional theatre: development of audition repertoire, unions, rounds, interviews, and survey of acting profession. Prerequisite: THEA 523.

526. ACTING FOR THE CAMERA (2) Development of techniques and skills necessary for media performance: commercials, soap operas, television drama, etc. Prerequisites: THEA 524, 525.
529. PERFORMANCE MONOGRAPH (1–2 per semester, maximum of 4) The development and presentation of M.F.A. monographs in acting or directing. Prerequisite: permission of graduate supervisor.
530. REHEARSAL METHODS FOR THE DIRECTOR (3) Theory and practice in approaches, procedures, and techniques in mounting a play. Prerequisites: THEA 434, 436, permission of instructor prior to registration.
531. DIRECTORIAL STYLES AND APPROACHES (1) Seminar in advanced theory and directorial practice. Designed for the advanced student of directing. Prerequisite: THEA 530.
532. DIRECTING SEMINAR (1) Career orientation for the director: résumé preparation, interviewing, unions, and survey of directorial opportunities. Prerequisite: THEA 531.
537. ARTISTIC STAFF FOR PERFORMANCE IN PRODUCTION (1 per semester, maximum of 6) Practical experience in choreography, dramaturgy, combat, special staging, voice/speech work, musical direction, or assisting in stage direction for university theatre production. Prerequisite: approval of the assignment by the producer (chair) prior to registration.
539. PROJECTS IN DIRECTING (1-2) Approved directing projects for the M.F.A. directing student. Prerequisites: THEA 435; admission to the M.F.A. directing program.
547. MAKEUP DESIGN FOR PRODUCTION (1 per semester, maximum of 6) Makeup design and execution for major university theatre production. Prerequisite: may be scheduled only with prior approval and production assignment.
550. SCENIC DESIGN III (3 per semester, maximum of 9) Advanced design; concentration on conceptualization, visual communication skills, portfolio production. Prerequisites: THEA 450; portfolio review.
551. SCENIC DESIGN IV (1-6) Advanced projects in scenic design. Prerequisite: THEA 550 or portfolio review.
552. SCENE DESIGN III (3) Design and project execution of plays and industrial installations. Prerequisites: THEA 551, M.F.A. theatre design candidacy.
553. SCENE DESIGN IV (3) Design of plays for proper theatre and mass media. Prerequisite: THEA 552, M.F.A. theatre design candidacy.
554. PERIOD RESEARCH FOR THE THEATRE (3) History of decor, styles, and movements in art and architecture. Prerequisite: M.F.A. candidacy.
555. TWENTIETH-CENTURY DESIGN (3) Seminar study of movements, practices, methods, and designers in the modern theatre. Prerequisite: M.F.A. candidacy or approval of the theatre arts department.
557. SCENIC DESIGN FOR PRODUCTION (1 per semester, maximum of 6) Design and execution of production design projects. Prerequisite: approval of proposed project by instructor prior to registration.
559. PORTFOLIO PRESENTATION (1 per semester, maximum of 2) Current practice in portfolio development and presentation to client and employer. Prerequisite: prior approval of faculty.
560. COSTUME DESIGN III (3 per semester, maximum of 9) Advanced costume design with emphasis on total production concept. Prerequisite: THEA 460 or portfolio review.
561. COSTUME DESIGN AND CONSTRUCTION (1-6) Advanced special projects for the graduate designer and costumer. Prerequisites: THEA 461 or 560; approval of proposed project by instructor prior to registration.
562. COSTUME DESIGN: RENDERING TECHNIQUES (3) Exploration and development of various rendering techniques with application to costume design. Prerequisite: M.F.A. candidacy.
563. COSTUME CONSTRUCTION: DRAPING (3) Exploration and development of various draping techniques with application to costume construction. Prerequisite: M.F.A. candidacy.
564. HISTORY OF COSTUME (3) Exploration of dress from Egyptian to modern. Prerequisite: permission of instructor prior to registration.
565. COSTUME CONSTRUCTION: PERIOD RECONSTRUCTION (3) Exploration and development of reproduction techniques relating to period clothing, and their application to costume construction. Prerequisite: M.F.A. candidacy.
566. COSTUME CONSTRUCTION FOR PRODUCTION (1 per semester, maximum of 6) Design and execution of production design projects. Prerequisite: approval of proposed project by instructor prior to registration.
567. COSTUME DESIGN FOR PRODUCTION (1 per semester, maximum of 6) Design and execution of production design projects. Prerequisite: approval of proposed project by instructor prior to registration.
- 568A. COSTUME DESIGN FOR RELATED PERFORMANCE ARTS (3) Exploration and development of costume design with application to the other arts (opera/dance/film). Prerequisite: M.F.A. candidacy.
- 568B. COSTUME DESIGN: PRODUCTION CONCEPTS (3) Exploration and development of costume design for specific production concepts. Prerequisite: M.F.A. candidacy.

TRAINING AND DEVELOPMENT

569. **COSTUME CONSTRUCTION: CRAFTS (3)** Exploration and development of various crafts techniques with application to costume construction (i.e., masks, jewelry, armor, millinery, footwear, wigs). Prerequisite: M.F.A. candidacy.
570. **STAGE LIGHTING DESIGN III (3)** Advanced techniques in the art of theatrical lighting design. Prerequisite: THEA 470.
571. **STAGE LIGHTING DESIGN IV (3)** Course addresses individual problems in the stage lighting design process concentrating on the development of skills necessary for professional examination. Prerequisite: THEA 570.
577. **LIGHTING DESIGN FOR PRODUCTION (1 per semester, maximum of 6)** Design and execution of production design projects. Prerequisite: approval of proposed project by instructor prior to registration.
580. **TECHNICAL PRODUCTION III (3)** Design consultation and specification of equipment, systems, and movable structures for new theatres; structures and projection devices for production. Prerequisite: THEA 480.
- 580A. **TECHNICAL PRODUCTION VII (3)** Mechanical design for the theatre; calculation for, and specification of, DC motors and controls, sprockets, chain drives, gearboxes, gearing, shafts for the movement of scenery. Prerequisite: THEA 480A, 483A.
- 580B. **TECHNICAL PRODUCTION VIII (3)** Planning of the theatre shop; emphasis on space design, renovation, upgrade, planning, outfitting, and safety; selection of tools and tool support systems. Prerequisite: THEA 480B.
581. **THEATRE ADMINISTRATION I (3)** Organizational structure and personnel; contracts; unions; budget preparation and control; administrative styles in theatre, opera, and dance. Prerequisite: THEA 481.
582. **THEATRE ADMINISTRATION II (3)** Fund-raising; promotion; audience development; audience survey technique; program development and strategies. Prerequisite: THEA 581.
583. **PROJECTS IN THEATRE ADMINISTRATION, MANAGEMENT, AND OPERATIONS (1-6)**
585. **THEATRE PLANNING (3)** Processes and problems in planning and designing theatres: performance, audience, and technical requirements.
586. **STAGE MANAGEMENT FOR PRODUCTION (1 per semester, maximum of 6)** Practical experience in production stage management for mainstage university theatre productions. Prerequisite: Approval of the proposed assignment by the instructor prior to registration.
587. **TECHNICAL PROJECTS FOR PRODUCTION (1 per semester, maximum of 6)** Execution of assigned technical projects for theatre production. Prerequisite: approval of proposed project by instructor prior to registration.
589. **DESIGN/PRODUCTION MONOGRAPH (1-4)** The development and presentation of M.F.A. monographs in design/production.
590. **COLLOQUIUM (1-3)**
595. **INTERNSHIP (1-3)** Professional field experience in theatre performance, production, and management assignments. Prerequisite: approval of internship by instructor prior to registration.
596. **INDIVIDUAL STUDIES (1-6)**
597. **SPECIAL TOPICS (1-6)**

TRAINING AND DEVELOPMENT (TRDEV)

ROBERT J. LESNIAK, *Coordinator of the Graduate Program in Training and Development*
Penn State Harrisburg
Middletown, PA 17057
717-948-6213

Degree Conferred: M.Ed.

The Graduate Faculty

William A. Henk, Ed.D. (West Virginia) *Professor of Education and Reading*
Robert J. Lesniak, Ph.D. (Syracuse) *Associate Professor of Education*
Steven A. Melnick, Ph.D. (Connecticut) *Associate Professor of Education*
Kathryn L. Towns, Ph.D. (Penn State) *Professor Emerita of Educational Psychology and Women's Studies*
Barry Williams, Ph.D. (Penn State) *Assistant Professor of Instructional Design*
Vicki Williams, Ph.D. (Penn State) *Assistant Professor of Instructional Design and Technology*

The Master of Education in Training and Development program at Penn State Harrisburg provides to full- and part-time students a curriculum designed to prepare adult trainers for industry, government, and health care institutions. Graduates may assume positions in organizations that utilize instruction, program

planning and evaluation, and development of instructional sequences for new employees, employees changing jobs, or employees who must learn new procedures.

The specific goals of the program are to develop in students the ability to assess training needs and develop a structured training process with predefined outcomes; to evaluate a training program; to prepare training materials; to facilitate group discussions and group processes; to translate learning needs into objectives and learning activities; to design and test theories and practices related to training and development; to evaluate and carry out research; and to describe common organizational structures found in business and industry, government, and medicine and how the training role relates to these structures.

Admission Requirements

An applicant must hold a baccalaureate degree in any field from a regionally accredited, college-level institution. Admission decisions are based primarily on an applicant's junior/senior cumulative grade-point average. Results of any postbaccalaureate course work, professional experience, and the applicant's statements provided in the application and goal statement also are considered. The best qualified applicants will be accepted up to the number of spaces available for new students.

Application Deadline

Candidates may enter the program at the beginning of fall or spring semester, or the summer session. To allow time for processing of applications, all required information must be received by 5:00 p.m. the second Friday in July for the fall semester, 5:00 p.m. the second Friday in November for the spring semester, and 5:00 p.m. the second Friday in April for the summer session.

Applicants who wish an early decision must have all required information on file by April 16 for the fall semester, July 10 for the spring semester, and November 13 for the summer session. Because of the need to obtain various clearances, applicants from outside the United States should submit all required information by the dates required for early admission decisions. Applications may be requested from the Penn State Harrisburg Admissions Office (717) 948-6200 or (800) 222-2056.

An applicant whose native language is not English is required to submit a score of 550 or higher on the Test of English as a Foreign Language (TOEFL). The TOEFL score must be submitted before the application will be considered.

Applicants with low grade-point averages may be required to take the Graduate Record Examination (GRE) or take 9 credits of course work recommended by a program faculty member and maintain a GPA of B or higher in order to be reconsidered.

Degree Requirements

Students may enter the Training and Development program from a variety of backgrounds and enroll in courses to help them develop competencies in training and development. The program has clearly stated guidelines for students and advisers and courses are scheduled to meet part- and full-time student needs.

There are two options in the program; the paper option requires the completion of a master's paper and a total of 36 credits (excluding an internship if one is needed). The nonpaper option does not require a master's paper, but does require a course in applied research design and an extra elective in training for a total of 39 credits (excluding an internship if one is needed).

Student Aid

Graduate assistantships available through this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*. GRE scores are required for candidates applying for assistantships.

COURSES

TRDEV 418. INSTRUCTIONAL METHODS IN TRAINING AND DEVELOPMENT (3)

TRDEV 421. PRESENTATION SKILLS FOR NEW TRAINERS (3)

TRDEV 432. TELEVISION PRODUCTION FOR TRAINING AND EDUCATION (3)

TRDEV 453. COMPUTER-BASED TRAINING: AUTHORITY SYSTEMS (3)

TRDEV 460. FOUNDATIONS IN TRAINING AND DEVELOPMENT (3)

TRDEV 495. INTERNSHIP IN TRAINING AND DEVELOPMENT (3-9)

TRDEV 497. SPECIAL TOPICS (1-9)

EDUC 506. CURRICULUM DEVELOPMENT AND INSTRUCTIONAL DESIGN (3) Examination of theory, issues, organization, and problems of curriculum development and instructional designs.

EDUC 565 LITERACY LEADERSHIP (3) Principles of supervision, organization, management, and evaluation of literacy programs will be presented. Prerequisite: EDUC 425, 471, 561, 562, 563.

WILDLIFE AND FISHERIES SCIENCE

EDUC 586. EDUCATIONAL RESEARCH DESIGNS (3) Identification of research designs appropriate to educational field and laboratory investigations and the development of a master's project proposal. Prerequisites: 15 credits in graduate study.

P ADM 500. PUBLIC ORGANIZATION AND MANAGEMENT (3) Development of public administration; administrative theory and practice in public organizations.

TRDEV 507. PROGRAM EVALUATION (3) Evaluation of educational and other human services programs; preparation and presentation of the evaluation proposal.

TRDEV 518. SYSTEMATIC INSTRUCTIONAL DESIGN IN TRAINING (3) Study of theory and practice of systematic instructional design. Application of instructional design principles to training problems in local organizations. Prerequisite: admission to graduate degree candidacy.

TRDEV 520. LEARNING STYLES, LEARNING THEORY IN TRAINING (3) Adult learning theory and its application to training and development.

TRDEV 531. TECHNOLOGY IN TRAINING (3) Introduction to the applications of various new instructional technologies to training problems.

TRDEV 533. DISTANCE LEARNING FOR TRAINERS (3) This course will explore a variety of instructional technologies that have direct applications in training adult learners at a distance. Prerequisite: admission to the Training and Development program.

TRDEV 583. ISSUES IN TRAINING (3) An issue seminar addressing topics such as: an unprepared work force, diversity, recession, and issues generated by the class. Prerequisite: graduate status.

TRDEV 587. MASTER'S PAPER (1-6) The development of an original master's project (paper, production, or practicum) supervised and judged by an appropriate faculty committee.

TRDEV 588. RESEARCH DESIGNS APPLIED TO TRAINING (3) Planning experimental, observation, survey and qualitative research designs for training setting needs such as needs assessments and evaluations. Prerequisites: EDUC 586, TRDEV 418, 460.

TRDEV 596. INDIVIDUAL STUDIES (1-9)

TRDEV 597. SPECIAL TOPICS (1-9)

WILDLIFE AND FISHERIES SCIENCE (W F S)

LARRY A. NIELSEN, *Director of the School of Forest Resources*

113 Ferguson Building

814-863-7093

Degrees Conferred: Ph.D., M.S., M.Agr., M.F.R.

The Graduate Faculty

Dean E. Arnold, Ph.D. (Cornell) *Adjunct Assistant Professor of Aquatic Ecology*

Margaret C. Brittingham, Ph.D. (Wisconsin) *Associate Professor of Wildlife Resources*

Robert P. Brooks, Ph.D. (Massachusetts) *Professor of Wildlife and Wetlands*

Robert F. Carline, Ph.D. (Wisconsin) *Adjunct Professor of Fisheries Science*

Paola C. Ferreri, Ph.D. (Michigan State) *Assistant Professor of Fisheries Management*

Thomas H. Martin, Ph.D. (North Carolina State) *Assistant Professor of Aquatic Ecology*

Larry A. Nielsen, Ph.D. (Cornell) *Professor of Natural Resources*

Gary J. San Julian, Ph.D. (Colorado State) *Professor of Wildlife Resources*

Charles P. Schaadt, Ph.D. (McGill) *Assistant Professor of Wildlife Technology*

Jay R. Stauffer, Jr., Ph.D. (Virginia Polytech) *Professor of Ichthyology*

Walter M. Tzilkowski, Ph.D. (Massachusetts) *Associate Professor of Wildlife Science*

Richard H. Yahner, Ph.D. (Ohio) *Professor of Wildlife Conservation*

Programs are designed to give students an understanding of the biology and management of terrestrial or aquatic wildlife species and their environments, and include training in fish and wildlife ecology, nutrition, physiology, behavior, and pathology of wildlife species; study of successional stages, land use, and management of various habitats and their impact on fish and wildlife populations; population dynamics and manipulation of animal numbers; and studies of recreational, aesthetic, and socioeconomic values of fish and wildlife. Most programs of study are strengthened by including appropriate courses offered by related departments.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are required for admission. A student may be

admitted provisionally without GRE scores. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Application materials should be submitted before February by those who want to begin in summer or fall. For admission, an applicant should have at least a 2.75 grade-point average, a 3.00 junior/senior average, and courses that are basic to the individual's field of specialization. Ordinarily these include 12 credits in communication, 12 credits in social sciences and humanities, 10 credits in quantification including calculus and statistics, 8 credits in chemistry and/or physics, 8 credits in biological sciences, and 18 credits in fish, wildlife, forestry, or related courses. Three reference reports (forms supplied on request), and a brief statement describing the applicant's academic goals, career interests, and special qualifications are required. The best-qualified applicants will be accepted up to the number of spaces available. Exceptions to admission requirements may be made for students with special backgrounds, abilities, and interests.

Admission to the Ph.D. program in Wildlife and Fisheries Science requires a master's degree in wildlife and fisheries science or a closely related field, or a bachelor's degree with a minimum grade-point average of 3.00 and demonstrated research ability.

Master's Degree Requirements

M.S.: In addition to Graduate School requirements, 6 credits of statistics and 2 credits of colloquium are required.

M.F.R.: A minimum of 30 graduate credits (400- to 500-level courses) is required, of which at least 20 must be earned at an established graduate campus of the University. At least 12 credits must be formal courses at the 500 level related to forest resources. A paper (3-6 credits of FOR/FP/WFS 596) is included as part of the 30 credits, demonstrating an ability to apply the knowledge gained during the program to the specialized field of interest; the paper will be evaluated by the student's committee. Two credits of colloquium and 3 credits of statistics (400- or 500-level) are required.

M.Agr.: Candidates select a minimum of 15 credits of graduate-level communications courses in majors such as Agricultural and Extension Education, Instructional Media, Journalism, Recreation and Parks, Speech Communication, English, and Theatre Arts. Any deficiencies in a student's resource specialty, as judged by his or her advisory committee, must be remedied. An acceptable paper on a selected professional problem or a report on internship training worth 3 credits or more also is required.

Doctoral Degree Requirements

Doctoral students would normally emphasize either wildlife or fisheries in their course selection. Course work shall include at least 15 graduate credits beyond those required for an M.S. in Wildlife and Fisheries Science. At least 9 of these credits must include courses at the 500 level with a Wildlife and Fisheries Science designation.

An international communications or cultural requirement is required for the Ph.D. degree. This requirement may be satisfied by demonstrating competence in one foreign language equivalent to passing two or three college-level courses. It also may be met by two courses in one or two contemporary foreign cultures. With approval of the doctoral committee, a student may petition the Graduate Faculty of the school for waiver of the international communications or culture requirement.

Students must pass the candidacy examination during their first year of residence and a comprehensive examination which is given after all course requirements have been completed. The final examination is oral; all doctoral students are required to present a public seminar on their dissertation prior to the final examination.

Other Relevant Information

Each entering student receives individual guidance from an adviser, and later from his or her committee, in designing a program of studies and research based on his or her own interests. The student is responsible for conforming to all requirements summarized in the "Graduate Studies Handbook" of the School of Forest Resources, and for completing the degree program within a reasonable time, i.e., two years for a master's degree and three years for a Ph.D.

Student Aid

In addition to the fellowships, traineeships, graduate assistantships, and other forms of financial aid described in the STUDENT AID section of the *Graduate Bulletin*, the following awards typically have been available to graduate students in this program:

FOREST RESOURCES: JESSEROSITER RAPP MEMORIAL SCHOLARSHIP—Available to graduate students in the School of Forest Resources who are not holding assistantships as graduate students. Apply to the School of Forest Resources' Scholarships, Loans, and Awards Committee.

WORKFORCE EDUCATION AND DEVELOPMENT

ROGER M. LATHAM MEMORIAL AWARD—Awarded to outstanding graduate students specializing in wildlife or fisheries after at least one semester in residence.

WILDLIFE AND FISHERIES SCIENCE (W F S)

- 407. ORNITHOLOGY (3)
- 408. MAMMOLOGY (3)
- 409. TERRESTRIAL WILDLIFE ECOLOGY LABORATORY (2)
- 410. GENERAL FISHERY SCIENCE (3)
- 430. CONSERVATION BIOLOGY (3)
- 446. WILDLIFE AND FISHERIES POPULATION DYNAMICS (3)
- 447W. WILDLIFE MANAGEMENT (3)
- 452. ICHTHYOLOGY (2)
- 453. ICHTHYOLOGY LABORATORY (2)
- 463. FISHERY MANAGEMENT (3)
- 495. WILDLIFE/FISHERIES INTERNSHIP (1–6)
- 496. INDEPENDENT STUDIES (1–18)
- 497. SPECIAL TOPICS (1–9)

529. FISH POPULATION DYNAMICS (3) Methods for analyzing fish population dynamics and their application to fisheries management. Prerequisite: a calculus course.

530. (FOR) CONSERVATION BIOLOGY (3) The application of biological principles to the conservation of biological diversity. Students who have passed W F S 430 may not schedule this course.

536. FRESHWATER FIELD ECOLOGY (3) Organisms and physical/chemical factors that affect them in the aquatic environment; basic water chemistry; identification of aquatic organisms. Prerequisite: BIOL 435.

542. (BIOL, ENT) SYSTEMATICS (3) Principles and methods of classification, phylogeny, and speciation; taxonomic techniques; analysis of species; causal interpretation of animal diversity.

550. WETLAND ECOLOGY AND MANAGEMENT (3) Discussions of the ecological, hydrologic, and cultural functions and values of freshwater and coastal wetlands. Prerequisite: 3 credits in ecological or hydrologic sciences.

551. WILDLIFE BIOMETRICS AND POPULATION ANALYSIS (3) Application of biometrics and mathematics to concepts and problems in wildlife ecology with emphasis on population analysis. Prerequisites: 3 credits in animal ecology and 6 credits in biometrics or statistics.

552. SYSTEMATICS AND EVOLUTION OF FISHES (3) Detailed study of the systematics, evolution, identification, and natural history of fishes. Prerequisites: BIOL 421, 452.

590. COLLOQUIUM (1–3)

596. INDIVIDUAL STUDIES (1–9)

597. SPECIAL TOPICS (1–9)

See also Forest Resources.

WORKFORCE EDUCATION AND DEVELOPMENT (WF ED)

EDGAR I. FARMER, *In Charge of Graduate Programs in Workforce Education and Development*
301 Keller Building
814-863-2596

Degrees Conferred: Ph.D., D.Ed., M.S., M.Ed.

The Graduate Faculty

Wesley E. Donahue, Ph.D. (Penn State) *Assistant Professor of Business Administration and Education*

Edgar I. Farmer, D.Ed. (Penn State) *Associate Professor of Education*

Kenneth C. Gray, Ed.D. (Virginia Polytechnic) *Professor of Education*

Mary J. Kisner, Ph.D. (Penn State) *Assistant Professor of Education*

Judith A. Kolb, Ph.D. (Denver) *Associate Professor of Education*

David L. Passmore, Ph.D. (Minnesota) *Professor of Education*

William J. Rothwell, Ph.D. (Illinois) *Professor of Education*

Richard A. Walter, Ph.D. (Penn State) *Assistant Professor of Education*

The general focus of the program is preparation for entry into professional positions within the broadly conceived field of workforce education and development, including human resource development in industry, secondary and postsecondary technical education, and employability programs for special populations. Emphases within the program include: training and development/human resources, leadership/administration, school-to-work, and postsecondary technical and community college leadership.

Admission Requirements

Scores from the Graduate Record Examination (GRE) are not required for admission but may be submitted. Requirements listed here are in addition to general Graduate School requirements stated in the GENERAL INFORMATION section of the *Graduate Bulletin*.

Admission will be based on evaluation of the candidate's grade-point average, educational experiences, work experiences, and letters of recommendation. Persons admitted must have successfully completed a B.S. degree with a 2.50 grade-point average in vocational industrial education or fields related to vocational, safety, or technical education, or health occupations. Two years or more of experience in vocational industrial education, industrial training, military technical training, or work experience in an occupation related to vocational industrial education, industrial training, vocational education, health occupations, safety education, or technical education are also required for admission. Exceptions to the minimum 2.50 grade-point average may be made for students with special backgrounds, abilities, and interests.

Degree Requirements

Students completing the M.S. may choose from three culminating experiences, a: (1) thesis, (2) essay, (3) paper, all of which must be acceptable to the student's adviser and the professor-in-charge. Students completing the M.Ed. may choose from four culminating experiences, (1) thesis, (2) essay, (3) paper, all of which must be acceptable to the student's adviser and the professor-in-charge, or (4) completion of a 3-credit independent study and successful completion of a written comprehensive examination. Candidates who choose to complete a formal thesis, which will be submitted to the Graduate School, must take 6 credits of WFED 600. Those choosing to complete a paper or essay must enroll in a minimum of 3 credits of WFED 596. Students must be enrolled during all semesters in which they are working with their adviser on these manuscripts. Subsequently, master's papers and theses are made available to others through the program's reading room.

The communication and foreign language requirement for the Ph.D. degree may be met by the successful completion of selected courses in statistics and computer programming.

Student Aid

Graduate assistantships available to students in this program and other forms of student aid are described in the STUDENT AID section of the *Graduate Bulletin*.

WORKFORCE EDUCATION AND DEVELOPMENT (WF ED)

- 402. SUPERVISION OF VOCATIONAL EDUCATION (3)
- 413. VOCATIONAL EDUCATION FOR SPECIAL NEEDS LEARNERS (3)
- 422. INTEGRATING COMMUNICATION SKILLS INTO THE VOCATIONAL CLASSROOM (3)
- 441. CONCEPTUAL AND LEGAL BASES FOR COOPERATIVE VOCATIONAL EDUCATION (2)
- 442. OPERATING COOPERATIVE VOCATIONAL EDUCATION PROGRAMS (2)
- 445. VOCATIONAL GUIDANCE (3)
- 450. CULTURAL DIVERSITY IN THE WORKPLACE (3)
- 471. TRAINING IN INDUSTRY AND BUSINESS (3)
- 495A. COOPERATIVE EDUCATION PRACTICUM (2)
- 495C. STUDENT TEACHING (10)
- 495D. INSTRUCTIONAL INTERNSHIP IN TRAINING (5)
- 496. INDEPENDENT STUDIES (1-18)
- 497. SPECIAL TOPICS (1-9)
- 498. SPECIAL TOPICS (1-9)

- 501. SEMINAR IN WORKFORCE EDUCATION (1-3) Conferences, colloquiums, discussions, and investigations of various topics and issues related to workforce education in the public and private sector.
- 508. WORKFORCE EDUCATION MANAGEMENT (3) Introduction to theories and concepts of managing workforce education programs in the public and private sector.

518. CURRICULUM AND INSTRUCTIONAL LEADERSHIP FOR WORKFORCE EDUCATION (3) Study of topics related to curriculum and instructional leadership in workforce education in the public and private sectors. Prerequisite: three years of professional experience in vocational education.
528. FISCAL AND FACILITIES MANAGEMENT FOR VOCATIONAL ADMINISTRATORS (3) Sources of revenue, budget preparation, purchasing, and the management of physical facilities in vocational education. Prerequisite: three years of professional experience in vocational education.
530. COLLEGE TEACHING FOR WORKFORCE EDUCATION (3) Structure and organization of collegiate programs in workforce education including faculty requirements, curricula, funded projects, and program evaluation. Prerequisite: acceptance as a graduate student in vocational industrial education.
531. SEMINAR IN INTERNATIONAL HOME ECONOMICS (1) Seminar for examining issues in international perspectives of home economics.
538. ADMINISTERING PERSONNEL SERVICES IN VOCATIONAL EDUCATION (3) Planning and implementing staff development activities, student guidance services, admissions, student organizations, and placement. Prerequisite: three years of professional experience in vocational education.
540. DATA ANALYSIS IN WORKFORCE EDUCATION AND DEVELOPMENT (3) Provides opportunities to acquire and practice skills in descriptive and inferential statistics.
541. PROGRAM EVALUATION IN WORKFORCE EDUCATION (3) Exploring positivistic and constructionist approaches to program evaluation, with emphasis on planning and management, accreditation, certification, licensure, criteria, and standards.
542. SOCIAL AND ECONOMIC FOUNDATIONS OF WORKFORCE EDUCATION AND DEVELOPMENT (3) Review of labor force, demographic and economic concepts, measures, and models.
543. EVALUATION OF INVESTMENTS IN WORKFORCE EDUCATION AND DEVELOPMENT (3) Use of labor supply models to evaluate investments in workforce education and development. Prerequisites: WF ED 540, 542, 550.
544. ANALYSIS OF POLICIES FOR WORKFORCE EDUCATION AND DEVELOPMENT (3) Explores models and methods for analyzing policies for workforce education. Prerequisites: WF ED 540, 550, 554.
545. ECONOMIC AND DEMOGRAPHIC MODELING OF POLICIES FOR WORKFORCE EDUCATION AND DEVELOPMENT (3) Use of economic and demographic models to plan and evaluate workforce education and development. Prerequisites: WF ED 540, 542, 550.
546. WORK-BASED EDUCATION (3) Discussion of legislation and educational requirements for education based at the worksite including cooperative education, youth apprenticeship, and apprenticeship programs. Prerequisite: WF ED 441.
550. RESEARCH IN WORKFORCE EDUCATION (3) Research techniques in workforce education.
557. PRESENT-DAY LOCAL, PERSONNEL, AND CURRICULUM PROBLEMS (2-3) Various plans, techniques, and practices.
559. MANAGING TECHNICAL EDUCATION (2-3) Concepts and issues pertinent to the effective administration and supervision of technical education at the secondary and postsecondary level. Prerequisites: 6 credits in industrial education, valid director's certificate, or equivalent training and experience.
560. HISTORICAL AND PHILOSOPHICAL FOUNDATIONS OF WORKFORCE EDUCATION (3) An investigation of historical, philosophical, and professional foundations of workforce education.
572. ORGANIZATIONAL DEVELOPMENT FOR INDUSTRIAL TRAINERS (3) An introduction to major concepts, skills, and techniques required by industrial trainers to support and facilitate organizational change. Prerequisite: WF ED 471.
573. NEEDS ASSESSMENT FOR INDUSTRIAL TRAINERS (3) Acquire skills to identify training and development needs, distinguish problems with management versus training solutions, develop and evaluate training solutions. Prerequisites: WF ED 471, 572.
574. STRATEGIC PLANNING FOR EDUCATION FOR WORK (3) Study of human capital as a component of education, industrial, and business training strategic planning at economy and organizational levels. Prerequisites: WF ED 471, 572, 573.
575. CURRENT POLICY AND PRACTICES IN INDUSTRIAL TRAINING (3) Analysis of training and development practices and their articulation with business practices. Prerequisites: WF ED 471, 572.
590. INDUSTRIAL TRAINING PROFESSIONAL SEMINARS (1) Study of special topics relating to problems, practices, methodologies, and special competency needs in industrial training. Prerequisites: WF ED 471, 572.
595. WORKFORCE EDUCATION ADMINISTRATIVE INTERNSHIP (2-15) Supervised study with an administrator or researcher at a cooperating school, state governmental agency, or research institution.
- 595A. FIELD-BASED PROJECT IN INDUSTRIAL TRAINING (2-5) Students identify a training and/or organization development problem in industry and/or business and carry out contract problem analysis and resolutions. Prerequisites: WF ED 471, 572.

- 595B. WORKFORCE EDUCATION ADMINISTRATIVE INTERNSHIP (2–15) Supervised study with an administrator or researcher at a cooperating school, state governmental agency, or research institution.
- 595C. INTERNSHIP IN COOPERATIVE VOCATIONAL EDUCATION (1–10) Validation of teaching and co-op coordinator competencies learned in prerequisite courses during interaction with professional staff while functioning under the supervision of a certified cooperative coordinator. Prerequisites: WF ED 441, 442.
596. INDIVIDUAL STUDIES (1–9)
597. SPECIAL TOPICS (1–9)

GRADUATE MINOR PROGRAMS

GERONTOLOGY

The interdisciplinary graduate minor in gerontology is administered by a committee of faculty appointed by the Gerontology Center Advisory Board. The committee members represent diverse programs within the University. Students admitted to the minor will develop a course of study that includes both prescribed course work and additional course work suited to the student's interests. The minor course of study will be developed jointly by the student, the student's academic adviser, and one member of the graduate minor gerontology committee. Contact the Gerontology Center (S-105 Henderson) for information regarding the committee membership.

The minor requires a minimum of 10 credits of the master's level and 15 credits at the doctoral level, 10 of which are prescribed. The prescribed courses are: BIOL 409 Biology of Aging (3); HD FS/PSY 445 Development throughout Adulthood (3); HD FS 590 Gerontology Colloquium (1); and SOC 435/HD FS 434 or SOC 535 (3). Doctoral students must select a minimum of 5 additional credits from among the following courses: ADTED 460, 505, CN ED 415, EDPSY 527, HD FS 446, 447, 579, H P A 442, KINES 481, 482, NURS 464, 500, NUTR 512, SOC 535, and gerontology-related special topics courses (SUBJ 497, 597) or independent studies (SUBJ 496, 596).

HIGH-PERFORMANCE COMPUTING

The executive committee of the Institute for High-Performance Computing Applications (IHPCA) administers this interdisciplinary minor. Each student's program is planned by the student and a designated IHPCA adviser, in consultation with the graduate adviser in the student's major field.

The minor offers an opportunity for students in all colleges and majors to pursue a focused set of courses that emphasize the use of high-performance computers to solve problems in science and engineering (and possibly other disciplines).

The minor requires 9 credits in high-performance computing courses for a master's degree and 15 credits for a doctoral minor. Six credits will be taken from AERSP 424, CSE 530, and NUC E 530. In addition, students selecting the minor are encouraged to register for one or both of the high-performance computing seminars offered in the fall and spring semesters.

Each of the core courses will be offered once every year. In addition, the course prerequisites can be met readily by students in science and engineering. For example, AERSP 424 requires only basic calculus and programming courses. NUC E 530 has AERSP 424 as a possible prerequisite and the instructors for CSE 530 and AERSP 424 have agreed to collaborate to make sure that AERSP 424 is an acceptable prerequisite for CSE 530. The situation for students with a nonscience background will be considered on a case-by-case basis.

The remaining credits required for the minor will include 400- and 500-level high-performance computing courses.

More information can be found on the IHPCA Web site: <http://www.psu.edu/dept/ihpca/>.

THE HUMANITIES

Doctoral candidates may pursue an individualized program of study leading to a certificate minor or option (15–18 credits) in a broadly interdisciplinary area in the humanities. This program typically provides teaching experience in an area of the humanities, and certification is granted by the College of the Liberal Arts.

LINGUISTICS

The doctoral minor provides interested students with an opportunity to complete a program of scientific study focused on the nature, structure, and use of human language. The minor is design to cover the foundations of the discipline of linguistics by reviewing fundamental core areas such as phonology and

GRADUATE MINOR PROGRAMS

syntax. Course work is also available in many additional areas of linguistics such as semantics, morphology, language variation, historical linguistics, and discourse analysis.

The minor requires a minimum of 15 credits, 6 of which must be at the 500 level. Nine credits are prescribed in syntax (LING 400), phonology (LING 404), and a general introduction to linguistics (LING 401), although a linguistics course at the 500 level may be substituted for LING 401 with the approval of the graduate officer.

LITERARY THEORY, CRITICISM, AND AESTHETICS

This is an interdisciplinary doctoral minor that is administered by two designated advisers, one from the Department of Comparative Literature and one from the Department of Philosophy. Students who are admitted to the minor will develop courses of study suited to their special interests. The minor for each student will be planned jointly by the student and the two advisers, in consultation with the student's doctoral adviser in his or her major field. Any change in the plan must be approved by all of the advisers.

A minimum of 15 credits must be selected from among the following courses (including at least 3 credits each in comparative literature and philosophy, chosen from the asterisked courses): ART H 410, CMLIT 502*, 503*, 580, ENGL 581, 582, 583, FR 571, GER 591, PHIL 413, 414*, 516*, 581, 582, SPAN 587, SPCOM 503, 505, 507, or THEA 503, 504.

Note 1: 3 credits of SUBJ 596 in one of the nine subject areas indicated may be substituted for one of the non-asterisked 3-credit courses.

Note 2: A student majoring in one of the nine subject areas may not include any courses in that field as part of the minor. Appropriate courses may be substituted.

RELIGIOUS STUDIES

This is a graduate minor administered by the Religious Studies program leading to a minor at the master's or doctoral level. Each student's course of study would be planned jointly by the student and an adviser selected from the Religious Studies faculty, in consultation with the student's adviser in his or her major field.

The minor requires a minimum of 9 credits of Religious Studies courses for a master's degree and 15 credits for a doctorate. These credits are in addition to the requirements for a student's major. Three credits consist of a required course, Research in Religious Studies (RL ST /HIST 565). Students would select among 500-level Religious Studies courses to fulfill the remaining requirements. These include: RL ST 532, 536, 539, 596, RL ST/HIST 510, 560, 561, 562, 563, 564.

With the consent of a student's adviser, the student may elect to take a 500-level course in a field closely related to Religious Studies that may help to satisfy the minor's requirements. This may not be in the student's major field.

SCIENCE, TECHNOLOGY, AND SOCIETY

This interdisciplinary graduate minor is administered by the Science, Technology, and Society Program. Each student's program will be planned by the student and designated S T S graduate adviser, in consultation with the graduate adviser in the student's major field.

The goal of the graduate minor in Science, Technology, and Society is to complement graduate and professional students' major programs through study of the interactions among science, technology, and society.

More specific objectives are to promote scholarship in the humanities and social sciences concerning the social and ethical dimensions of science and technology; to inform those training in the scientific and technical professions about the social and ethical dimensions of their professional practice; and to develop research and rhetorical skills used in shaping public discourses about, and public policies regulating, science and technology.

The minor requires 9 credits in S T S courses for a master's and 15 credits for a doctoral minor. Six credits consist of S T S 589 Ethics and Values in Science and Technology and S T S 591 Research and Writing in S T S. The remaining credits may include 400- and 500-level, special topics (S T S 497 and 597), and independent study (S T S 496 and 596) courses.

WOMEN'S STUDIES

This interdisciplinary graduate minor is administered by the Women's Studies program. Each student's minor is planned by the student and the Women's Studies graduate adviser in consultation with the student's graduate adviser in his or her major field.

The minor requires a minimum of 9 credits of Women's Studies courses for a master's degree and 15 credits for a doctorate. These credits are in addition to the requirements for the student's major. Six credits consist of required course in feminist theory (3) and feminist methodology (3). The remaining credits may include a combination of WMNST 400- and 500-level courses, as well as special topics courses (numbered 497 and 597) and independent/individual studies (496 and 596).

Prescribed courses (6 credits): WMNST/HD FS 507 Feminist Theory; WMNST 597 Feminist Perspectives on Research and Teaching. Additional courses (a minimum of 3 credits at the 500 level for the master's degree and 9 credits [6 at the 500 level] for the doctorate) from WMNST 400- and 500-level, special topics, and independent study courses.

OTHER COURSES CARRYING GRADUATE CREDIT

The following courses are interdisciplinary or in fields in which graduate major work is not offered at Penn State. The courses, however, carry graduate credit and, with the approval of the major department head or program chair, may be applied toward the requirements for a degree either as elective courses or as a part of a general studies program. All 400-level courses, which are listed in the Penn State *Baccalaureate Degree Programs Bulletin*, may carry graduate credit, subject to approval by the major department head or program chair.

AFRICAN AND AFRICAN AMERICAN STUDIES (AAA S)

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

CHINESE (CHNS)

596. INDIVIDUAL STUDIES (1-9)

CLASSICS (CLASS)

500. INTRODUCTION TO CLASSICAL SCHOLARSHIP (1-6) Lectures on the methods and materials of classical scholarship. To be scheduled by graduate students in their first semester and as necessary thereafter.

501. COMPARATIVE GREEK AND LATIN GRAMMAR (3) The evolution of the phonological, morphological, syntactic and lexical structures of Greek and Latin from Proto-Indo-European. Prerequisites: GREEK 003; LATIN 401, 402, or 403; LING 102 or 502.

504. TOPOGRAPHY OF ANCIENT ROME (3) Lectures and readings on physical development of the ancient city of Rome from earliest habitation to time of later empire.

597. SPECIAL TOPICS (1-9)

CLASSICS AND ANCIENT MEDITERRANEAN STUDIES (CAMS)

502. THE SANSKRIT LANGUAGE (3) An introduction to the structure and history of Sanskrit, with special emphasis on reading and translating. Prerequisite: GREEK 003 or LATIN 003.

503. SEMINAR ON ANCIENT MEDITERRANEAN LANGUAGES (3 per semester, maximum of 6) An in-depth examination of the ancient languages of the Mediterranean basin, including Indo-European and non-Indo-European languages. Prerequisites: GREEK 003, LATIN 003, LING 502, 505.

596. INDIVIDUAL STUDIES (1-9)

COMPUTATIONAL FLUID DYNAMICS

Students interested in computational fluid dynamics may select the following courses, which are described under the majors of Aerospace Engineering and Mechanical Engineering: AERSP 423, AERSP (ME) 526, 527, AERSP 529, 597B, 597G, and ME 540.

EARTH AND MINERAL SCIENCES (EM SC)

596. INDIVIDUAL STUDIES (1-9)

ENGINEERING (ENGR)

588. SEMINAR FOR TEACHING ASSISTANTS IN ENGINEERING (1) A seminar course considering instructional issues and principles for engineering instruction and industrial training.

594. MASTER'S PAPER RESEARCH (1-3) Investigation of a specific engineering problem and development of a scholarly written report in partial fulfillment of requirements for a master's degree in engineering.

OTHER COURSES CARRYING GRADUATE CREDIT

GREEK (GREEK)

509. GREEK SEMINAR (3-9)

517. GREEK RESEARCH (1-6) Prosecution of an assigned problem under the guidance of a member of the department.

HEBREW (HEBR)

596. INDIVIDUAL STUDIES (1-9)

ITALIAN (ITAL)

588. SEMINAR IN ITALIAN LITERATURE (3-12) Common and individual research in special problems.

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

JAPANESE (JAPNS)

596. INDIVIDUAL STUDIES (1-9)

JEWISH STUDIES (J ST)

505. (HIST) BIBLICAL HISTORIOGRAPHY IN ITS ANCIENT SETTING (3 per semester/ maximum of 6) Methods of historical reconstruction in Biblical and other historiography from the earliest Mesopotamian records through those of the sixth century B.C.E. Prerequisite: HIST 102.

508. (HIST) ANTISEMITISM IN HISTORICAL CONTEXT (3) Historical and comparative analysis of occurrences of antisemitism from antiquity to the present.

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

LATIN (LATIN)

510. LATIN SEMINAR (3-6)

518. LATIN RESEARCH (1-6) Prosecution of an assigned problem under faculty guidance.

LINGUISTICS

500. SYNTACTIC THEORY II (3) Further development of the generative-transformational model; the analysis of higher-order grammatical structures. Prerequisite: LING 400.

502. HISTORICAL LINGUISTICS (3) Principles of comparative linguistics; language families; reconstruction of phonemic, morphemic, and syntactic structure of extinct languages. Prerequisite: LING 400.

504. GENERATIVE PHONOLOGY (3) Distinctive feature theory in the generative framework; articulatory and acoustic correlates; nonphonemic features. Prerequisite: LING 500.

505. SEMINAR IN HISTORICAL LINGUISTICS (3) Detailed study of some problem of historical linguistics, e.g., the laryngeal theory, Indo-European ablaut, etc. Prerequisite: one course in historical linguistics.

535. DISCOURSE ANALYSIS (3) Linguistic analysis of spoken and written texts. Prerequisite: LING 401.

545. WORD-FOUNDATION THEORY (3) Critical survey of approaches to the study of word formation; special emphasis on the role of morphology in a generative grammar. Prerequisites: LING 400, 404.

570. FOUNDATIONS OF LINGUISTIC THEORY (3) A critical survey of generative-transformational grammar from 1957 to the present.

590. SEMINAR IN INTERDISCIPLINARY LINGUISTICS (3-12) Methods of research. Common and individual investigations in interdisciplinary fields of linguistics in consultation with one or more interdisciplinary instructors. Prerequisite: LING 500.

596. INDIVIDUAL STUDIES (1-9)

597. SPECIAL TOPICS (1-9)

LITHUANIAN (LITH)

500. STRUCTURE OF LITHUANIAN (3) Analysis of the phonology, morphology, and syntax of Lithuanian; comparative linguistic study of Balto-Slavic and Indo-European. Prerequisite: one graduate course in linguistics.

PATHOLOGY (PATH)

501. PRINCIPLES OF PATHOLOGY (4) The fundamentals of reaction to injury at cellular and tissue levels, emphasizing the pathogenesis of functional, structural, and biochemical abnormalities.
520. BIOLOGY OF NEOPLASIA (3) Detailed examination of the initiation and pathogenesis of animal neoplasm with emphasis on the relationship to human neoplasia.

PEDIATRICS (PED)

525. CLINICAL GENETICS (5–10) Mendelian and molecular principles of human genetics; genetic bases of human disease, quantitative human genetics, prenatal diagnosis, genetic counseling.
526. HUMAN CYTOGENETICS (2) Human chromosome identification; structure, replication, and evolution of human and other eukaryotic chromosomes in cytogenetic and molecular terms.

PORTUGUESE (PORT)

588. SEMINAR IN PORTUGUESE AND BRAZILIAN LITERATURE (3–12) Common and individual research in special problems.
596. INDIVIDUAL STUDIES (1–9)
597. SPECIAL TOPICS (1–9)

RELIGIOUS STUDIES (RL ST)

510. (HIST) TOPICS IN MEDIEVAL CHURCH HISTORY (3–6) Institutional and doctrinal development of the Christian Church in medieval Europe.
532. RELIGION AND SOCIAL PROBLEMS (3–6) Study of a selected social issue, or constellation of issues, with analysis of its religious and normative dimensions.
536. RELIGIOUS STRUCTURES AND PROCESSES (3–6) Study of the relationship between religion as social structure and as dynamic social function.
539. ADVANCED STUDIES IN RELIGIOUS ETHICS (3–6) A systematic study of the structure and essential themes of ethics of religious institutions and thinkers.
560. (HIST) TOPICS IN AMERICAN RELIGION (3 per semester, maximum of 6) The social, political, and intellectual contexts of American religious thought.
561. (HIST) TOPICS IN WESTERN RELIGION (3 per semester, maximum of 6) Major issues and themes in the historical development of Christianity and Judaism.
562. (HIST) TOPICS IN COMPARATIVE RELIGION (3 per semester, maximum of 6) Comparative studies of world religions.
563. (HIST) RELIGION AND SOCIETY (3 per semester, maximum of 6) Social and political implications of religious belief and practice.
564. (HIST) TOPICS IN ASIAN RELIGIONS (3 per semester, maximum of 6) Topics in Asian religions.
565. (HIST) RESEARCH IN RELIGIOUS STUDIES (3) Approaches and methodologies in the critical study of religion.
566. (HIST) ISLAMIC STUDIES (3) Studies in Islamic history, historiography, theology, law, and religious life.
590. COLLOQUIUM (1–3)
596. INDIVIDUAL STUDIES (1–9)
597. SPECIAL TOPICS (1–9)

RUSSIAN (RUS)

- *001G. TECHNICAL RUSSIAN FOR GRADUATE STUDENTS (3) Prepares student to translate technical and scientific texts. No previous knowledge of Russian is required.
- *002G. RUSSIAN TEXTS (3) Development of skill in translating Russian texts in the sciences and social sciences. Prerequisite: RUS 005 or 001G.
525. PUSHKIN (3) Pushkin's significance in Russian literature; his relation to other European literatures; Eugene Onegin and selected shorter works.
530. SEMINAR IN NINETEENTH-CENTURY RUSSIAN LITERATURE AND CULTURE (3 per semester/maximum of 6) Major issues in nineteenth-century literature and culture (novel and social thought, the short story, drama before Chekhov, and others). Prerequisites: RUS 304, 360.
540. EIGHTEENTH-CENTURY RUSSIAN LITERATURE (3) Study of the major writers and literary developments in this period of the secularization and modernization of Russian literature.

*No graduate credit is given for this course.

OTHER MEMBERS OF THE GRADUATE FACULTY

542. SEMINAR IN TWENTIETH-CENTURY LITERATURE (3-6) Major works and issues in twentieth-century Russian literature and culture. Prerequisite: RUS 304 or 330.
560. HISTORY OF THE RUSSIAN LITERARY LANGUAGE (3) Historical development of the Russian literary language and tradition. Prerequisites: RUS 304, 360.
570. OLD RUSSIAN LITERATURE (3) Analysis of Russian literary monuments in the original, 1100-1700. Prerequisite: SLAV 550.
602. SUPERVISED EXPERIENCE IN COLLEGE TEACHING (1-3 per semester, maximum of 6)

SCIENCE, TECHNOLOGY, AND SOCIETY (S T S)

500. INTEGRATING SCIENCE AND TECHNOLOGY INTO SOCIETY (3) Interdisciplinary analysis of critical issues for science, technology, and society. Prerequisite: graduate standing at Penn State.
555. (R SOC) HUMAN DIMENSION OF NATURAL RESOURCES (3) Identification of the interrelationships and influence of human behavior and natural resources.
589. ETHICS AND VALUES IN SCIENCE AND TECHNOLOGY (3) Study interrelationships of twentieth-century technological change and human values with emphasis on social and ethical aspects of technological progress.
590. COLLOQUIUM (1-3) Prerequisite: graduate standing at Penn State.
591. RESEARCH AND WRITING IN SCIENCE, TECHNOLOGY, AND SOCIETY (3) Overview of current research in S T S with training on doing S T S research and preparing research reports for publication. Prerequisite: second-semester graduate standing.
594. RESEARCH TOPICS (1-18)
596. INDIVIDUAL STUDIES (1-9)
597. SPECIAL TOPICS (1-9)

SLAVIC (SLAV)

500. BIBLIOGRAPHY AND RESEARCH TECHNIQUES (3) Tools and methods of research, designed for students preparing to do independent investigation of problems in Slavic languages and literatures.
510. STRUCTURE OF THE SOUTH SLAVIC AND WEST SLAVIC LANGUAGES (3-12; 3 credits per language) Linguistic analysis of a particular South Slavic (Bulgarian, Macedonian, Serbo-Croatian, Slovenian) or West Slavic (Czech, Lusatian, Polish, Slovak) language. Prerequisite: RUS 460 or one graduate course in linguistics.
550. OLD CHURCH SLAVIC (3) Reading and study of that corpus of religious and liturgical documents representing the first written records of a Slavic tongue.

WOMENS STUDIES (WMNST)

515. (GEOG) GENDER AND GEOGRAPHY (3) Explanations of links between gender relations and spatial structures.
516. (HIST) TOPICS IN GENDER HISTORY (3) A critical analysis of gender and theories of gender in selected historical contexts.
541. (ADTED) WOMEN AND MINORITIES IN ADULT EDUCATION (3) Seminar on women and minority adults as learners and leaders in various contexts of adult education. Prerequisite: ADTED 460.
565. (ANTH) WOMEN AND DEVELOPMENT (3) Interaction of women and development.
594. RESEARCH TOPICS (1-15)
595. INTERNSHIP (1-18) Supervised off-campus, nongroup instruction, including field experiences, practicums, or internships. Written and oral critique of activity required.

OTHER MEMBERS OF THE GRADUATE FACULTY

Gerald N. Knoppers, Ph.D. (Harvard) *Associate Professor of Jewish Studies and Classics and Ancient Mediterranean Studies*

Charles S. Prebish, Ph.D. (Wisconsin) *Associate Professor of Religious Studies*

William R. Schmalstieg, Ph.D. (Pennsylvania) *Professor of Slavic Languages*

Judith Van Herik, Ph.D. (Chicago) *Associate Professor of Religious Studies and Jewish Studies*

APPENDIX I

CONDUCT

The Pennsylvania State University recognizes the basic rights and responsibilities of the members of the University and accepts its obligation to preserve and protect those rights and responsibilities. Further, the University must provide for its members the opportunities and protections that best serve the nature of the educational process.

The Code of Conduct governing the behavior of members of the University must ensure the basic rights of individuals as well as reflect the practical necessities of the community. The code also must prohibit or limit acts that interfere with the basic purposes, necessities, or processes of the University or with the rights of its members. Finally, the code must reconcile the principles of maximum freedom and necessary order.

Violations of the Code of Conduct shall be adjudicated by appropriate University mechanisms established in consultation with faculty, students, and staff. The mechanism for adjudicating cases of alleged misconduct on the part of student members of the University is the discipline system described in the following section of this document. Student members of the University are those who have been accepted for admission to the University or who are registered or enrolled in any credit or noncredit course or program offered by the University. There shall be clearly defined channels and procedures for such adjudication and the right of appeal. Sanctions shall be commensurate with the seriousness of the offense and may include separation (suspension, dismissal, and expulsion) from the University. Repeated violations justify increasingly severe sanctions.

The Code of Conduct shall be made public in an appropriate manner and may be revised by the University in consultation with the faculty, students, and staff.

Code of Conduct—Misconduct that may result in disciplinary action consists of the following offenses:

1. Violation of written University policy or regulations contained in any official publication or administrative announcement of The Pennsylvania State University;
2. Academic dishonesty, including, but not limited to, cheating and plagiarism;
3. Disruption of operations of the University as defined in the “Open Expression and Disruption” statement;
4. Harassment of an individual or group as defined in the “Policy Statement on Acts of Intolerance”;
5. Furnishing false information to the University or other similar forms of dishonesty in University-regulated affairs, including knowingly making false oral or written statements to any University discipline board;
6. Forgery, alteration, destruction, or misuse of University documents, records, identification cards, or papers;
7. Failure to comply with directions of or to present identification to University officials acting in the performance of their duties, or refusal to respond to a request to report to an administrative office;
8. Unauthorized entry into or use of University facilities;
9. Use, possession, or carrying of firearms (including, but not limited to, pistols, rifles, shotguns, or ammunition), billy club, dirk, knife or other dangerous weapons while on University-owned or controlled property, or at University-sponsored or supervised activities, except by authorized law officers and other persons specifically authorized by the University;
10. Use, possession, or distribution of alcoholic beverages on University property as defined in the “Policy Statement on Beverages Containing Alcohol”;
11. Use, possession, distribution, or being under the influence of controlled substances or unlawful drugs, except when permitted by law (see “Policy Statement on Drugs”);
12. Theft of or damage to property of the University or to property of any of its members or visitors or knowing of possession of stolen property;
13. Sexual assault and abuse as defined in the “Policy Statement on Sexual Assault and Abuse”;
14. Physical abuse of any person on University-owned or controlled property, or at a University-sponsored or supervised function; or conduct that threatens or endangers the health or safety of a person;
15. Disorderly conduct or lewd, indecent, or obscene conduct on University-owned or controlled property or at University-sponsored or supervised activities;
16. Sexual harassment as defined in the “Policy Statement on Sexual Harassment”;
17. Causing or participating in hazing, as defined in the policy relating to registration of student organizations;

18. Behavior that would constitute a violation of local, state, or federal law on University property, or off campus when such behavior has a substantial adverse effect upon the University or upon individual members of the University community;

19. Aiding, abetting, or attempting to commit an act or action that would constitute an offense under any of the types of misconduct stated under items 1 to 18 above.

APPENDIX II

RESOLUTION OF PROBLEMS

In the Classroom—Students are occasionally confronted with classroom situations (exclusive of grades and grading) that cause them concern and/or inconvenience. Examples include:

—failure of a faculty member or administrator to uphold University policies, such as prohibition of smoking in classrooms, prohibition of scheduling comprehensive examinations during the last week, or early completion of semesters.

—failure of a faculty member to fulfill his or her instructional obligation, such as unjustified cancellation of classes, frequent absenteeism or late arrival, absence during designated office hours, or inappropriate substitution of teaching assistants.

A graduate student who believes that a problem exists has several avenues of appeal. The avenue chosen by a student will depend on the type of problem encountered and the personal wishes of the student.

Most problems may be resolved by discussing the matter with the faculty member directly involved, with the department head and/or with the student's adviser.

However, if the nature of the problem or any other reason prompts a graduate student to believe that this avenue of appeal is inappropriate, the student may seek recourse through the office of the appropriate associate or the assistant dean of the college or division in which he or she is enrolled, or with the dean of the Graduate School. Action of these offices, if deemed appropriate by both the student and the administrators, shall occur within 30 days of the complaint or by the end of the semester, whichever comes first.

Students may use this channel of communication with assurance that confidentiality will be maintained as appropriate: only information required to pursue a course of action as requested, or consented to, by the student in writing will be disclosed. A record of each incident is to be kept by the Graduate School for not less than five years from the date of the resolution of the complaint.

Concerns about course grades and grading should be dealt with between the student and his or her instructor as outlined in University Faculty Senate Policies 47-00, 48-00, and 49-00.

College officers are prepared to help students with classroom problems of the types listed.

Outside the Classroom—Occasionally, between faculty and graduate students there are disagreements that cannot be resolved in the administrative structure in a department, program, or intercollege program. Problems to be considered under the following guidelines do not include classroom matters; rather they involve alleged violations of freedom, professional ethics, and procedural fairness and consistency. There may be disagreements concerning authorship credit and disputes and problems not covered by other procedures. Whenever possible, disagreements are to be resolved within the department, program, or intercollege program in which the student or faculty member is based. If resolution cannot be achieved at that level, the following procedures are to be followed. If for some reason the proper jurisdiction is not clear, the dean of the Graduate School shall decide on the appropriate procedure.

1. For disagreements that are unresolved at the department or program level, the grievance process will be initiated when a graduate student or faculty member files a written grievance with the dean of his or her college. In the case of nondegree or intercollege program students, the grievance must be filed with the dean of the Graduate School. The parties to the grievance process shall be the person filing the grievance and the person responsible for the act or omission giving rise to the grievance.

2. In response to the grievance, the college dean (or the dean of the Graduate School) convenes a hearing committee. From that time until the hearing ends, the college dean (or dean of the Graduate School) refrains from involvement in the dispute. The committee consists of three graduate students from within the student's college, three faculty members, and an administrator (this latter from outside the department, program, or intercollege program from which the disagreement originated), who will be chairperson.

3. Each party is allowed up to three disqualifications from this committee without cause. An indefinite number of disqualifications are allowed with cause, as determined by the college dean (or the dean of the Graduate School for nondegree students or students in intercollege graduate programs). The college dean (or the dean of the Graduate School) makes additional appointments as necessary to full staff the hearing committee.

4. The hearing committee attempts to resolve the disagreement within thirty calendar days of receiving the complaint.

5. The hearing is not public. During the hearing, either party may have present an adviser, who must be a student, faculty, or staff member of the University. In light of the nature and spirit of the proceeding, representation by legal counsel is prohibited.

6. The hearing committee may have present at the hearing such assistance as it deems necessary.

7. The hearing committee is not bound by strict rules of evidence and may admit any relevant evidence.

8. A tape recording of the hearing will be made available to both parties.

9. The parties are afforded an opportunity to obtain necessary witnesses and documentary or other evidence. The department, program, or intercollege program involved makes all reasonable efforts to cooperate with the committee in securing witnesses and making available documentary and other evidence.

10. Each party has the right to confront and cross-examine all witnesses. Expenses incurred in obtaining a witness will be the responsibility of the party requesting the witness.

11. The hearing committee's findings are based solely on the hearing record.

12. The hearing committee submits its findings and recommendations in writing to the college dean (or the dean of the Graduate School) and to the parties. Based solely on the record of the hearing, the college dean (or the dean of the Graduate School) may endorse all, part, or none of the hearing committee's recommendations. If the college dean (or the dean of the Graduate School) does not endorse all the findings and adopt all the recommendations of the hearing committee, a written explanation of the decision is provided to the hearing committee and the parties. The record of this decision, along with supporting evidence, shall be kept by the Graduate School for not less than five years from the date of the resolution of the complaint.

13. A decision by a college dean may be appealed by any party to the dean of the Graduate School. The review and decision by the dean of the Graduate School is in accordance with section 12.

14. The dean of the Graduate School may seek the advice of the Graduate Council Committee on Graduate Student and Faculty Affairs before making a determination.

APPENDIX III

TERMINATION

Procedures for Termination of the Degree Program of a Graduate Student for Unsatisfactory Scholarship—When the department head, program officer or program committee determines that the program of a graduate student must be terminated for unsatisfactory scholarship, the student must be given advance notice, in writing, which in general terms shall advise the student of the academic reasons for the termination.

Upon receipt of this notice the student has the opportunity to seek a review of this decision. If the student desires such a review, the student must, within ten days of receipt of the notice, submit a written appeal to the department head or program chair. The department head or program chair then provides an opportunity for the student to meet with the faculty member(s) who made the decision to terminate the student's program.

Formal rules of evidence are not applicable to the meeting, and attorneys are not permitted to represent any person attending the meeting. If the student's faculty adviser did not participate in the decision to terminate, the adviser should be permitted to attend this meeting if requested by the student or the department head or program chair, or if the adviser wishes to do so. The department head or program chair person is responsible for keeping minutes of the meeting and for distributing copies of the minutes to all those in attendance.

Following this meeting, the department head or the program chair must notify the student, in writing, whether the termination decision has been sustained or reversed. If it is sustained, the department head or program chair shall notify the dean of the Graduate School.

Within five days of receiving this notice of termination for unsatisfactory scholarship, the student may make a written request to the dean of the Graduate School for a further review of the decision. The standard of review by the Graduate School is whether the decision to terminate for unsatisfactory scholarship was arbitrary and capricious. The terms "arbitrary and capricious" mean that the decision to terminate is not supportable on any rational basis, or that there is no evidence upon which the decision may be based. Because the Graduate School does not review faculty judgments as to the quality of a student's academic performance, the fact that the Graduate School might reasonably reach a contrary decision on the same evidence considered by the faculty is not sufficient to determine that the faculty decision was arbitrary and capricious.

Although not required to do so, the dean of the Graduate School may meet with the student and/or the faculty member, or request additional information from either the student or the faculty members. If a meeting is held, the student may not be represented by an attorney but may have present a faculty adviser of his or her choice. The student is permitted to submit additional information or statements in writing.

After this review, the dean of the Graduate School either sustains the termination and directs that it be entered on the student's transcript or, only if he or she determines that the decision was arbitrary and capricious, reverses the decision and permits the student to continue in the program. The dean of the Graduate School gives written notice of the decision to the department head or program chair and to the student. In the event of a reversal, such written notice shall contain a statement of the basis on which the decision was made.

If the student indicates that illegal discrimination either was the reason for the termination or caused the unsatisfactory scholarship, the Graduate School shall not review the decision, but shall refer the matter to the appropriate University hearing body established to review such claims.

A hold may be put on a student's records while action is pending under this procedure.

APPENDIX IV

TERMINATION OF ASSISTANTSHIPS DUE TO INADEQUATE PERFORMANCE

PREFACE—The purpose of this policy is to provide guidance to units in dealing with inadequate performance by graduate assistants. This policy applies only to inadequate performance by a graduate assistant of his or her duties and responsibilities during the term of appointment. It does not apply to (i) a decision by the unit not to renew an assistantship appointment, (ii) matters involving the academic performance of the graduate assistant, and (iii) the automatic termination of an assistantship appointment when the graduate assistant is no longer a student.

POSITION DESCRIPTIONS—Duties and responsibilities of graduate assistants vary widely among units, and even within units. In light of the nature of the obligations of a graduate assistant, it is not always feasible to provide a written description of the graduate assistant's duties and responsibilities. Where possible, however, it is recommended that the unit prepare a written statement of the duties and responsibilities of a graduate assistant (a "position description"). If a position description is prepared by the unit, it should be made available to the recipients of an assistantship at the time awards are made. [If there is no general position description used by the unit, the unit should provide a written statement of duties and responsibilities to the individual at the time he or she is awarded the assistantship.]

PERFORMANCE IMPROVEMENT MEETING—When a supervisor determines that a graduate assistant is failing to meet acceptable standards, the supervisor will meet with the assistant. Together, they will review the duties and responsibilities expected of the graduate assistant, and the supervisor will identify those areas in which the performance of those duties and responsibilities is judged to be substandard. The supervisor should then advise the graduate assistant that if his or her performance does not improve to a satisfactory level within a time period specified by the supervisor, the assistantship will be terminated. The time period established by the supervisor should provide a sufficient and reasonable time for the graduate assistant to demonstrate a satisfactory level of performance. In some instances, the graduate assistant's failure to meet acceptable standards of performance may be disruptive of the educational process (e.g., failure to appear for a teaching assignment class, or failure to grade examinations in a timely fashion). In such instances, the graduate student should be advised that any subsequent failure to meet acceptable performance standards may result in immediate termination. As soon as possible following this meeting (generally within three days) the supervisor will provide the assistant with a written summary of the meeting, a copy of which will also be sent to the administrator of the unit.

TERMINATION OF ASSISTANTSHIP—If a graduate assistant fails to meet acceptable standards of performance as prescribed in the performance improvement meeting, the supervisor will notify the administrator of the unit. The unit administrator will schedule a meeting with the supervisor and graduate assistant as soon as possible, generally within three days. At that meeting, the graduate assistant's performance will again be reviewed. If it is concluded that the graduate assistant has failed to meet acceptable performance standards, the administrator of the unit may terminate the graduate assistantship appointment. The administrator of the unit will provide a written summary of the meeting and of the action taken to the graduate assistant, the dean of the college, and the associate dean of the Graduate School.

APPEALING THE TERMINATION OF ASSISTANTSHIPS—If a graduate assistant wishes to appeal a termination decision, he/she may follow the grievance process in the policy titled, "Resolution of Problems—Outside the Classroom."

APPENDIX V

A. PENNSYLVANIA CLASSIFICATION—A student shall be classified as a Pennsylvania resident for tuition purposes if that student has Pennsylvania domicile and that student's presence in Pennsylvania is not primarily for educational purposes. Domicile is a person's existing and intended fixed, permanent and principal place of residence. A student whose presence in the Commonwealth is primarily for educational purposes shall be presumed to be a non-Pennsylvania resident for tuition purposes. The following are considerations that may be used by the University in determining whether a student is a resident for tuition purposes.

1. A student under the age of 21 is presumed to have the domicile of her/his parent(s) or legal guardian(s), unless the student has maintained continuous residence in the Commonwealth for other than educational purposes for a period of at least 12 months immediately prior to her/his initial enrollment at The Pennsylvania State University, and, the student continues to maintain such separate residence.

2. A student who has resided in the Commonwealth for other than educational purposes for at least a period of 12 months immediately preceding her/his initial enrollment at The Pennsylvania State University is presumed to have a Pennsylvania domicile.

3. A student who has not resided continually in Pennsylvania for a period of 12 months immediately preceding her/his initial enrollment at The Pennsylvania State University is presumed to have a non-Pennsylvania domicile.

4. A student requesting to be classified as a Pennsylvania resident for tuition purposes must be a citizen of the United States or must have indicated by formal action her/his intention to become a citizen or must have been admitted to the United States on an immigrant visa. A student admitted to the United States on a tourist or a student (nonimmigrant) visa is not eligible for a classification as a Pennsylvania resident for tuition purposes unless the student has indicated by formal action her/his intention to become a United States citizen.

5. A United States government employee or member of the armed forces who was a resident of Pennsylvania immediately preceding her/his entry into government service and who has continuously maintained Pennsylvania as her/his domicile will be presumed to have a Pennsylvania domicile. Military personnel and their dependents who are assigned to an active duty station in Pennsylvania and who reside in Pennsylvania shall be charged in-state tuition rates.

6. A student receiving a scholarship, guaranteed loan, grant, or other form of financial assistance dependent upon residence in a state other than Pennsylvania is not a Pennsylvania resident for tuition purposes.

B. RECLASSIFICATION OF RESIDENCY—A student requesting reclassification as a Pennsylvania resident for tuition purposes must demonstrate by clear and convincing evidence that her/his domicile is Pennsylvania, and that her/his presence in Pennsylvania is not primarily for educational purposes. Each request shall be decided individually on the basis of all evidence submitted by the Petitioner. Accordingly, it is not possible to list a specific combination of factors or set of circumstances that if met, would ensure reclassification for tuition purposes.

C. RECLASSIFICATION PROCEDURE

1. A student may challenge her/his residence classification by filing a written petition with the person or committee designated to consider such challenges at the University. Such person or committee shall consider such petition and render a timely decision that shall constitute exhaustion of administrative remedies.

2. Any reclassification resulting from a student's challenge or appeal shall be effective at the beginning of the semester or session during which the challenge or appeal was filed or at the beginning of the following semester or session. The decision as to which semester or session becomes the effective date shall rest with the person or committee rendering the decision on reclassification.

3. A student who changes her/his place of residence from Pennsylvania to another state is required to give prompt written notice of this change to the University and shall be considered for reclassification as a non-Pennsylvanian for tuition purposes effective with the date of such change.

4. A dependent resident student whose parent(s) or legal guardian(s) move outside of the Commonwealth may remain a Pennsylvania resident for tuition purposes if she/he continues to maintain a separate domicile within the Commonwealth.

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